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W. G. FARLOW.

# AGRICULTURAL SCIENCE.

EDITOR: CHARLES S. PLUMB.

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# CONCERNING THE GROWTH OF MAIZE.

BY C. S. PLUMB.

The following data are the result of research carried on by myself at the New York agricultural experiment station during the season of 1886, and have not heretofore been published in any form. It is thought that the results are of sufficient interest and importance to warrant publication, in view of the fact that similar work has appeared elsewhere.[1]

A very level piece of clay-loam ground, situated where drainage was good, yet preserving a fair amount of moisture at all times, was fitted for corn in May, 1886, no manure being applied. The land was made as smooth as possible without compacting it unreasonably, and on May 21, at 5 P. M., ten grains of maize were planted in ten separate spots, each being 44 inches apart. At no time were the conditions abnormal, excepting that there was no hilling of the soil, or horse cultivation. The hand hoe was occasionally used to keep down weeds, and prevent the soil from becoming caked or hard. Four standard thermometers were placed in the ground three inches deep, equally distributed over the plat, so that an average of the four would give a fair record of the soil temperature. From the day of seed planting, until the end of the experiment, measurements were carefully made of leaf and panicle growth, and records taken from the thermometers, rain gauge and sunshine recorder. It will be well to note at this point that of the ten kernels planted, only seven germinated; the plants from these all grew well till the end of the season.

The corn was measured daily at 2 P. M., Sundays inclusive, at an hour when the atmosphere is generally considered warmer than at any other time. In order to make as fair measurements as possible, the plant growth was taken at the greatest leaf extension in height, but, upon the appearance of the panicle, the measurement was made upon that, and the leaf discarded. The point where the measurement was changed is indicated by an asterisk, which also means appearance of panicle.

The following figures in table I give the height of plants, soil temperatures, total daily sunshine, and rainfall.

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[1] Annual report Penn. agric. experiment station, 1887, pp. 87-89.

## TABLE I.

| Date— | May 31 | June 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hight of plant. Inches. | .5 | 1. | 1.5 | 2. | 2.7 | 3.7 | 4.5 | 5. | 6.2 | 7.5 | 8.2 | 8.7 | 9.7 | 11. | 12. | 12.5 | 13. | 14.5 |  | 16. | 17.7 | 20.5 | 21.5 | 22.7 |
|  |  |  |  | .75 | 1.5 | 2. | 3.2 | 4. | 5.2 | 5.7 | 7.2 | 8.2 | 9. | 9.5 | 10.5 | 11.5 | 12.5 | 13. |  | 15.2 | 16.5 | 17. | 19.5 | 21.5 |
|  |  |  |  | .40 | 1. | 1.5 | 1.7 | 2.7 | 4. | 4.7 | 5.5 | 6.5 | 7.5 | 8.2 | 8.7 | 9.5 | 11. | 11.7 |  | 12.7 | 14.5 | 16. | 17.2 | 18.2 |
|  |  |  |  |  | 1. | 1.2 | 1.5 | 2.5 | 3.2 | 3.7 | 4.7 | 5.5 | 6. | 6.5 | 6.7 | 7.7 | 8.5 | 9. |  | 9.7 | 11. | 12. | 12.7 | 14.2 |
|  |  | .75 | 1.25 | 1.75 | 2.5 | 3.5 | 4.2 | 4.7 | 5.5 | 6.5 | 7.2 | 8. | 8.2 | 8.7 | 10. | 10.7 | 11.5 | 11.7 |  | 14. | 15. | 16. | 17.5 | 19.2 |
|  |  |  |  | .75 | 1.5 | 2.5 | 3.3 | 4. | 5. | 5.7 | 6.7 | 8. | 8.5 | 8.5 | 10. | 10.7 | 11.5 | 12.2 |  | 14.5 | 15.7 | 16.5 | 18.5 | 20.5 |
|  |  |  |  |  | .3 | .6 | .7 | 1.2 | 1.5 | 2. | 2.2 | 3. | 3.5 | 3.7 | 4.7 | 5.5 | 6. | 6.2 |  | 7.7 | 8.7 | 9.5 | 10.5 | 12.2 |
| Soil temp. | 81. | 69. | 67.5 | 72.5 | 82. | 75. | 69. | 78.5 | 80. | 69. | 83. | 86. | 86. | 86. | 85. | 86. | 84. | 74. | 79. | 73. | 84. | 82. | 75. | 79. |
|  | 81.5 | 70. | 67.5 | 72.5 | 82. | 76. | 69. | 79.5 | 80.5 | 69. | 84.5 | 88. | 88. | 86. | 86. | 87. | 85.5 | 74. | 79.5 | 73. | 86. | 82. | 75. | 80. |
|  | 82. | 69. | 67.5 | 72.5 | 82. | 76. | 69. | 79. | 81. | 69. | 84.5 | 87. | 89 | 86. | 87, | 89. | 85.5 | 74. | 79. | 73. | 86. | 82. | 75. | 80. |
|  | 80. | 69. | 67. | 72. | 82. | 76. | 69. | 78.2 | 80.5 | 69. | 83.5 | 85. | 87. | 88. | 86. | 87. | 84.2 | 74. | 79.5 | 73. | 85. | 82. | 74.5 | 79.5 |
| Av. |  | 69. | 67.5 | 72.5 | 82. | 76. | 69. | 78.7 | 80.5 | 69. | 83.7 | 86.5 | 87.5 | 86.5 | 86. | 87.2 | 84.7 | 74. | 79.2 | 73. | 85.2 | 82. | 75. | 79.5 |
| Sunshine. | 12-30 | 3-30 | 0-45 | 11-45 |  |  |  | 1-30 | 7-0 | 2-45 | 12-15 | 13-30 | 12-45 | 10-0 | 14-0 | 13-45 | 9-15 | 2-0 |  | 1-30 | 9-15 |  | 1-30 | 10-30 |
| Rainfall. |  | .40 in. | 33in |  |  |  | .03 in. |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | .31in |  |

| Date— | June 24 | 25 | 26 | 27 | 28 | 29 | 30 | J'ly 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hight of plant. Inches. | 24.5 | 26. | 27.5 | 29.2 | 30. | 31.7 | 34. | 35.2 | 36.7 | 38. | 39.5 | 40.5 | 42.5 | 43. | 43.5 | 44.5 | 45.2 | 46.5 | 47. | 48.2 | 49. | 49. | 49. | 49. |
|  | 22.7 | 23.5 | 24.5 | 26.5 | 28.7 | 30.2 | 32. | 34. | 36.2 | 37.7 | 38.7 | 39.5 | 42. | 42.7 | 43.2 | 44.5 | 45.7 | 46.5 | 48. | 49.2 | 50.7 | 51.5 | 52.7 | 53. |
|  | 20. | 21. | 22.7 | 24. | 25. | 25.7 | 29.5 | 30.5 | 31.5 | 33. | 36. | 36. | 37.5 | 37.7 | 38. | 39.5 | 39.7 | 40.5 | 41. | 42.5 | 44. | 45.2 | 46.5 | 46.7 |
|  | 15.5 | 16.2 | 17.2 | 19.5 | 21.5 | 23.2 | 25. | 27.2 | 29.5 | 31. | 32.5 | 32.7 | 33.7 | 34.7 | 35.2 | 36. | 37. | 37.7 | 39. | 39.5 | 40.2 | 41.2 | 42.5 | 44. |
|  | 20.7 | 21.5 | 22.5 | 23. | 24.7 | 26.7 | 28.2 | 29. | 30. | 32.2 | 33.7 | 35. | 35.2 | 35.7 | 36. | 36.5 | 37.5 | 38. | 38. | 38.7 | 40.7 | 41. | 41. | 41. |
|  | 21.7 | 22.5 | 23. | 25.7 | 27.7 | 29.5 | 29.5 | 32. | 34.5 | 36. | 35.5 | 38. | 39.2 | 40.5 | 41.7 | 43.5 | 44. | 44. | 46. | 46.5 | 46.7 | 48. | 49.5 | 52. |
|  | 13.2 | 14. | 14.7 | 16. | 17.7 | 20.2 | 20.5 | 22.2 | 24.2 | 25.5 | 26.7 | 27.7 | 29.5 | 30.5 | 31. | 32. | 33.5 | 34.2 | 36. | 36.2 | 38.2 | 39.5 | 40.2 | 41.5 |
| Soil temp. | 70. | 77. | 81. | 87. | 90. | 92. | 95. | 95.7 | 94.5 | 95. | 94. | 87.7 | 86. | 92. | 96.5 | 80. | 71. | 82. | 98. | 93.7 | 92. | 77. | 93. | 84. |
|  | 70. | 77.5 | 81.5 | 87. | 90. | 91. | 95. | 96. | 95.5 | 97. | 94.5 | 89. | 86. | 91. | 96. | 80. | 71. | 81. | 96. | 90 | 86.5 | 76. | 90. | 83.5 |
|  | 70. | 77.5 | 81. | 88. | 90.5 | 93. | 97. | 95.7 | 95. | 97. | 94. | 88. | 85.7 | 93. | 96.5 | 79. | 71. | 85. | 99. | 94. | 91. | 77. | 94. | 85. |
|  | 70.5 | 77.5 | 81.5 | 87.7 | 89. | 93. | 97. | 93.7 | 94.5 | 96. | 94. | 88. | 86. | 93. | 97. | 80. | 72. | 84. | 98. | 94. | 92. | 77. | 94. | 84. |
| Av. | 70. | 77.5 | 81.2 | 87.5 | 90. | 92. | 96. | 95.2 | 95. | 96.2 | 94. | 88. | 86. | 92.2 | 96.5 | 80. | 71. | 83. | 98. | 93. | 90.5 | 77. | 93. | 84. |
| Sunshine. |  | 9-30 | 13-30 | 11-30 | 13-45 | 13-30 | 12-0 | 11-0 | 12-30 | 10.15 | 11.15 | 4-45 |  | 12-45 | 13- | 4-15 | 2-15 | 13- | 13- | 11-15 | 11-30 | 1-30 | 10.45 | 4- |
| Rainfall. | .09 in. |  |  |  |  |  |  |  |  |  |  |  | .18 in. |  |  | .53 in. |  |  |  |  |  |  | .05in | .15in |

| Date— | July 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | Aug. 1 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hight of plant. Inches. | 49.7 | 50.7 | 53. | 54. | 56. | 57. | 57.2* | 60.7 | 63.2 | 65.5 | 66.5 | 66.7 | 67. |  |  |
|  | 53.5 | 55. | 55.7 | 57.5 | 59.5 | 60.2 | 61.* | 66. | 69. | 72.5 | 74.7 | 75.2 | 76. | 76.7 |  |
|  | 47. | 48.5 | 51. | 52.7 | 55. | 55. | 57.* | 61.5 | 64. | 65.7 | 67. | 67.5 | 67.7 |  |  |
|  | 45.5 | 47.5 | 50. | 53. | 55. | 56.5 | 60. | 64. | 67.7 | 72.* | 75.5 | 78.2 | 79.7 | 80.7 |  |
|  | 41.7 | 43.2 | 45.2 | 49. | 52. | 53.2 | 54.* | 58. | 60.7 | 62.2 | 63. | 63.5 |  |  |  |
|  | 53.5 | 55. | 56.7 | 57.5 | 59.2 | 60.2 | 61.5 | 62.7 | 67. | 70 | 71.7 | 72.5* |  |  |  |
|  | 42.2 | 43.5 | 45.5 | 48. | 50. | 50.5 | 52. | 56.7 | 58.7 | 62.7 | 65. | 67.2* | 68.2 | 68.5 | 68.7 |
| Soil temp. | 75.5 | 90. | 90.5 | 87. | 83.5 | 84.2 | 90. | 76.5 | 86. | 91.5 | 93. | 87. | 95. | 96. | 94.5 |
|  | 74. | 87. | 91. | 87.5 | 83.5 | 81. | 87. | 76. | 84. | 91. | 92.5 | 84. | 95. | 95. | 95. |
|  | 75.5 | 92.5 | 91.5 | 88.5 | 84.5 | 85. | 92. | 77. | 86.5 | 94. | 96.5 | 89. | 98.5 | 100. | 98.5 |
|  | 75. | 89.5 | 90.5 | 88. | 83.5 | 84. | 91. | 77. | 86. | 92.5 | 94.5 | 88. | 96.5 | 97.5 | 96. |
| Av. | 75. | 90. | 91. | 88. | 83.5 | 83.5 | 90. | 76.5 | 85.5 | 92.2 | 94.2 | 87. | 96.2 | 97. | 96. |
| Sunshine. | 1-15 | 11-0 | 11-0 | 3-15 | 4-30 | 9-0 | 10-30 | 0-30 | 8-0 | 12-30 | 11-15 | 7-0 | 11-30 | 11-45 |  |
| Rainfall. | .53 in. |  | in. | 2.64 | 1.23 | in. |  | 1.06in. | .05 in. |  |  |  |  |  |  |

The above figures represent the complete data of this experiment, and are given in full for future reference. In order, however, to trace more easily the relation of growth to climatic conditions, I will select the figures in growth, noted every seven days and append the total temperature, sunshine and rainfall which accumulated in a week's time. To this table I will add the total standard air temperature, as recorded at the station, [1] which is not included in table I. Below in table II we find the following record :

TABLE II.

| Date of observation. | (1) June 6 | (2) 13 | (3) 20 | (4) 27 | (5) July 4. | (6) 11 | (7) 18 | (8) 25 | (9) Aug. 1. |
|---|---|---|---|---|---|---|---|---|---|
| (1) | 4.5 | 11. | 17.7 | 29.2 | 36.5 | 46.5 | 49.7 | 60.7 | |
| Hight (2) | 3.2 | 9 5 | 16.5 | 26.5 | 38.7 | 46.5 | 53 5 | 66. | |
| of (3) | 1.7 | 8.2 | 14.5 | 24. | 36. | 40.5 | 47. | 61.5 | |
| plant. (4) | 1 5 | 6.5 | 11. | 19.5 | 32.5 | 37.7 | 45.5 | 64. | |
| Inches. (5) | 4.2 | 8 7 | 15. | 23. | 33.7 | 38. | 41.7 | 58. | |
| (6) | 3.3 | 8.5 | 15.7 | 25.7 | 35 5 | 44. | 53.5 | 62 7 | |
| (7) | .7 | 3.7 | 8.7 | 16. | 26.7 | 34.2 | 42.2 | 56.7 | 68.7 |
| Total air temperature for 7 days........ | 452° | 475° | 494° | 466° | 492° | 523° | 464° | 472° | |
| Total soil temperature for 7 days.. ...... | 517° | 572° | 569° | 553° | 658° | 597° | 610° | 602° | 648 |
| Total hours sunshine..... | 28½ | 59¾ | 49¾ | 46½ | 84¼ | 50 | 52¾ | 49¾ | |
| Total inches rainfall ...... | .76 | 0 | 0 | .40 | 0 | .71 | .73 | 4.93 | .05 |

The above table shows, in a comparatively clear manner, the rate of growth in the plants, and the conditions which induced this development, excepting the physical one of the soil, and the food in air and soil, factors the effect of which we are at present unable to estimate. However it can be assumed, and fairly I believe, that these latter conditions affected each plant equally.

First, have these climatic conditions had an equal influence on development in growth of each plant? Referring to table one, it will be noticed that plant one vegetated on May 31, and plants four and seven on June 4, the latter being especially backward. Comparing their growth as shown in table two, we have the following :

Increase in growth pr wk. of plant 1=+6.5+6.7+11 5+10.2+7+3.2+11. in.
" " " " " 4=+5. +4 5+8.5+13 +5 7+7.7+18.5"
" " " " " 7=+3. +5. +7.2+10.7+7.7+8. +14.5"

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[1] Fifth annual report N. Y. agricultural experiment station, 1886, p. 356.

These figures present a decidedly uneven growth, and show that plants, like animals, grow according to the conditions of life most favoring them. For example, plants one and two began active growth for several days before the other five appeared above ground, yet they made the smallest ultimate growth of the seven, while that plant which vegetated last, grew more days, and attained a greater hight than any of the others.

What will the average growth of all the plants for each period show us? Adding up the figures in period eight (July 25), and combining all the air temperatures, etc., each by itself, we find that under the influence of 3,838 degrees of air temperature, 4,678 of soil temperature, 421 hours and 15 minutes of sunshine and 7.53 inches of rainfall, was made a total growth in height of 429.6 inches. Then dealing with the plants collectively, and taking an average for the growth of all, for each period, we get the following figures:

| Period | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| The average hight of all the plants was | 3 in. | 8 in. | 14 in. | 23 in. | 35 in. | 41 in. | 47 in. | 61 in. |
| Increase in growth from period to period | | +5 " | +6 " | +9 " | +12 " | +6 " | +6 " | +14 " |

It is noticeable that the growth is very unsteady, the rate of progression being constant for the first five periods, then dropping low for two periods, or 14 days, and finally making during the last week the greatest growth of all, viz.: 14 inches, more than twice as much as was gained the preceding two periods.

What is the cause of this vacilation in development? It will be noted that a gain of 12 inches was made during the fifth period. We might assume that this was due to the fact that this week combined what are thought to be the most favorable circumstances for maize growth, viz.: high temperature of air and soil, abundant sunshine and no rainfall. Yet this cannot be so, for when the greatest growth was made, in period eight, the air and soil temperature were respectively 20 and 56 degrees less than in period five, the sunshine was much less, and while there was no rainfall in period five, nearly five inches fell in period eight.

It is reasonable to assume however, that the cause of the depression in growth during periods six and seven, was due to the sudden loss of soil heat and sunshine. It is very presumable, that, if this change had been more gradual, the growth would have been more constant. From period six to seven the average is held, and from seven to eight comes the striking increase in growth, the period in which four of the seven plants first presented the panicle. While this fact may possibly be the cause of this great gain of eight inches during one week, this cannot be positively so for plants six and seven made almost no growth after the appearance of the panicle, though the other five made good developments. However, it would be just as reasonable to assume that the very heavy rainfall occurring during period eight, coupled with the warm temperature and sunshine, were accountable for this increase. In fact this statement is in accordance with the opinion of Frear[1], who says that very rapid growth of plants is to be seen immediately after a rainfall, a very considerable proportion of the increase in size being due to an expansion of the cells of the plant with water.

While the above facts do not indicate the true increase in total plant development, and show whether one plant is heavier in dry matter than another, they furnish fair evidence of the comparative field growth of maize. And in conclusion, based on the figures already considered, we may assume,

1st, that maize makes a positive daily growth upward from the appearance of the plant above ground, till it has reached its maximum hight.

2d, that the variation in the development of the plant is not controlled by meteorological conditions, for of two plants, the one which is the most backward at the beginning of the season of growth, may eventually be the stronger, larger and more vigorous of the two.

Tennessee agricultural experiment station,
Knoxville, December, 1888.

# EDITORIAL.

AN intimate friend of the editor, for whose opinions we have the highest regard, writes us that he wishes that more news might be published in the "experiment station items," and that a department for inter-communications of ideas between station workers be established.

This magazine is now upon its third year of existence, and we trust that it has materially improved. Its financial condition is sound, and the character of the contributions of volume two, certainly was of a high order. And yet we have never been burdened with contributions from our readers. Of the nearly 300 persons engaged is scientific work at experiment stations at the present time, but a very small percentage of these, as we believe, take any interest whatever in contributing to a scientific journal of this kind. The agricultural chemists of the country have from the first taken a warm interest in this journal, and most of our contributions have come from them. The botanists, entomologists and other workers have preferred to present their papers to journals devoted to their exclusive line of study, without reference to the agricultural features; in fact we have not up to date published a leading article embodying entomological research, sent us by an entomologist. Even those engaged in strictly agricultural research have given the magazine almost no literary support. They prefer to present their contribution to the popular agricultural press of the country, which is all very well so far as it goes.

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[1] Ann. report Penn. state college agr. exp, sta., 1887, pp. 86.

We do not make these remarks in a complaining manner, but simply to show the position this magazine is in. We should be glad to publish more items of interest to station workers, but how are we to secure them unless they are sent us by these same persons? We have before this expressed our desires for station notes.

We have faith in the future of this magazine, but our hopes are not highly colored. Contributions will come in gradually, but not profusely, and they will not until the station and college employes of this country are given more moderate amounts of work to do, and are not made to cover far more ground than four times their number of men should. Further, while we have many able scientists engaged in agricultural work, there are far too many who haven't the slightest qualifications for their positions, and whose support and aid we cannot look for.

In view of these facts, it makes it all the more necessary that the workers of a higher class assist in maintaining a technical journal in their line of research, in other ways besides financial ones. With only one journal of this character in the English language, it does seem as though it ought not to lack for contributions.

## RECENT LITERATURE.

THE INCREASE IN THE PRODUCE OF THE SOIL through the rational use of nitrogenous manure. By Prof. Paul Wagner, Ph. D., pp. 72, photographs 2. London: Whittaker & Co., 1888.

This volume is translated from the German by Geo. G. Henderson, assistant to the professor of chemistry in the university of Glasgow. After a careful examination of this most interesting book, we wonder is the translator at fault in his work, or is Dr. Wagner never failing in his judgment, for certainly the positive assertions in this translation smack of bravado, and cause one to ask himself if the author is not assuming more knowledge than the circumstances will allow.

In answer to the question, does the application of nitrogenous manure produce an increased yield of all field crops? the following facts are given. Different plants were manured with 18, 31.5 and 45 lbs. of nitrogen per acre. Barley, rye, oats, wheat, buckwheat, carrots, potatoes, turnips, flax, rape, grass and spurry gave a considerable increase, the gains being exactly proportional to the increase of manure, while on similar soils, no extra yields of peas, red clover, lupines, vetches and lucern were obtained. The latter plants possess a specific capacity for absorbing nitrogen, different from the former, taking it from sources inaccessible to them, so that under normal conditions of cultivation the plants do not need manuring with nitrogenous salts.

The author then goes on to compare the growth of the embryo wheat and pea plants. The wheat plant lives upon the organic food of the seed, and then ceases growth for about eight days, when it can begin feeding on inorganic food, such as potash, phosphoric acid and nitrogenous salts in the soil, on which it lives till the fruit is ripe. However, the pea plant at the stage where the wheat begins to eat of the soil nitrogen,, begins feeding on the nitrogen of the air, and from this time forward takes *all* of its nitrogen from the air. This fact Wagner says has been incontestably established, a very interesting statement to say the least.

The plants of the farm are divided into two classes, *nitrogen increasers* (peas, vetches, etc.) and *nitrogen consumers* (wheat, rye, etc.), the former drawing nitrogen from a supply inaccessible to the latter—*i. e.*, the nitrogen of the air.

To show that these leguminoseæ do not depend on the soil nitrogen for that food, it is stated that vetches grown on sand barren or poor in nitrogen, show a decided want of this food, and are sickly, pale colored, until suddenly nature takes pity on the plants, new life begins almost instantaneously, and they become dark colored, active growth commences, and the plants vegetate as plentifully as though manured with nitrates.

In discussing how large are the extra crops which can be obtained by the use of a fixed quantity of nitrogenous manure, it is shown that average figures from very extended series of experiments give almost incredible differences. Apropos of field experiments, the author says, carried out as they have been hitherto, with their results for the most part so indiscriminately and faultily set forth, they can throw no light on the question as to the power of the different cultivated plants to make use of nitrogenous manure. A table is given, showing what increases may be expected with various crops, by using 100 lbs. of nitrate of soda per acre.

The statement is made that with oats, 100 pounds of nitrate of soda can produce no less than 600 lbs. of grain and 1000 lbs. of straw, and in that case both grain and straw contain no higher percentage of nitrogen than the produce obtained from non-nitrogenous manure. The percentage of nitrogen in the produce is *never* increased unless the nitrogenous manure cannot exert its full influence.

Interesting pot experiments were carried on in three series. The soil in I was relatively poor in phosphoric acid, and manuring with nitrogen or potash alone produced none or little effect, superphosphate alone inducing a considerable increase, and causing a necessity for nitrogen, though none for potash. Soil II is similar to I, and shows no need for potash. It is a trifle richer in phosphoric acid and poorer in nitrogen than I. With soil III phosphoric acid alone had little or no effect, as it was already in excess, for manuring with nitrate of soda alone brought on a very considerable increase in growth, yet not to such an extent that all the manure has exerted its full influence, which is only brought about by the addition of phosphoric acid.

In advising farmers in applying manures, Wagner says the nitrogen should be *measured* out to the plants as exactly as possible, but not the phosphoric acid and potash. The quantity of phosphoric acid in the soil must be great enough to not only satisfy the *normal* hunger of the plant for phosphoric acid, but still more to offer enough when the plant occasionally acquires a perfect *craving* for this food. This rule also holds good for potash. Where plant food is concerned, nitrogen is the proper regulator of the activity of production of all plants requiring that food.

Space is devoted to an interesting discussion of the proper time to apply nitrogenous manure, especially nitrate of soda to winter wheat. It is erroneous to give the plants all the nitrate in the fall. This can only be risked on a very deep soil, which retains water strongly, this danger of deep sinking, however, being greater with nitrate of soda than ammonium sulphate. It is wiser to sow a part of the nitrate at or immediately after the seeding, or a week or so later, and the balance top dressed in the spring just before the plants begin to head. The following rule is given : only so much soluble nitrogen should be given the cereals *before* the close of the time of stem formation, as it is necessary for the production of the most profitable number of stalks, and *after* the time of stem formation, so much soluble nitrogen should be given as is requisite for the strongest possible development of the stalks and grain. In experiments carried out on rye, on this point, the best results come from no nitrate of soda in the fall, but applied in spring. It is considered that in many cases it will be better and involve less loss of nitrogen not to drill in nitrate with the seed, but apply as a top dressing.

There is also danger of loss of nitrogen from having the field thinly sowed. If 100 lbs. nitrate of soda are to be divided between

1,000,000 plants on a given area, they will consume this with more ease than will one-half that number of plants on the same ground and surface. But if the latter make strong growth in every way, they will consume the nitrate as completely as the million plants. And as there are limits to the growth and development of the plants, on a certain land surface, the number should not be allowed to fall below the minimum, to get the best results.

Dr. Wagner states that he will shortly publish a new work, giving the results of a large number of experiments, wherein it will be shown that rape and mustard do not collect nitrogen from the atmosphere, Märker to the contrary.

What Märker considers a disposition, from an excessive manuring of phosphoric acid, to make plants "live faster," Wagner says is not so, but that they die sooner. If a plant manured with an excess of phosphoric acid has formed much plant substance, that is, has consumed much nitrogen and potash, and perhaps water, the supply of nourishment in the soil will come to an end correspondingly sooner, and so a "hunger" for nitrogen or potash, and a thirst for water will set in sooner than when the plant has not been manured with an excess of phosphoric acid, so that the plant ceases from production and permits the completion of the proper ripening process without hindrance. The writer sarcastically says plant-physiologists need not trouble themselves with explaining why plants thus cease to suspend activity of growth; it must simply be *hunger* and *thirst* which makes the plant tired of life.

Experiments were conducted on oats to ascertain if it is true that nitrate of soda causes an excessive absorption of phosphoric acid and potash, and his results were as follows: (a) When no manure was used the amount of phosphoric acid in the straw was three times as large as when nitrogenous manure was used; (b), when nitrate of soda was applied the amount of potash in the straw was one-fourth smaller than when no manure or the other nitrogenous salts were used. The interesting statement is made that only soluble substances, capable of migration, can get into the grain, the insoluble phosphoric acid compounds being left in the straw.

Experiments were carried out to compare the differences in effect of nitric acid and ammonia. With grass, oats, rye, buckwheat and rape, if these manures were applied in the spring, usually no considerable differences in effect were shown, though the ammonia in several series gave results fully equal to nitric acid. In other series the effect of ammonia was 10 to 15 per cent. less than that of nitric acid. According to the author's experiments on soils containing some quantity of lime, ammoniacal manure acted just as quickly as nitrate of soda, and when heavy and continuous rains fell shortly after sowing, more quickly than nitrogen as nitrate of soda.

In a chapter devoted to green manuring, much interesting matter is presented. The nitrogen collectors do not need nitrogen fed them as manures, but on no account must be allowed to suffer from want of phosphoric acid and potash. For the acid, Thomas slag is recommended as cheap and acceptable.

While this volume is replete with valuable information, presented in a form especially interesting to agricultural scientists, it is notable that the author gives a minimum amount of attention to the physical conditions of the soil as affecting his results—in fact, seems to ignore them. If such is his intention, then his conclusions are of necessity uncertain. On page 31 he says: "This manuring produced *no* increase in the crops, just because the yield of 3,870 lbs. of grain, which was obtained without nitrogenous manure, stood at the limit fixed by climate and weather." It will here be noted that everything, according to the author, hinges on manure, climate and weather. Again on page 44, he says, speaking of the attainable maximum yield, "The limits within which the attainable maximum of yield is variable are wide in proportion to the variations in the character of the climate and of the yearly weather."

The following quotation will be read by many with amusement: "Let us consider for a moment how the nourishment of plants by nitrogen proceeds in a field not manured with nitrogen salts, but productive and retaining its original strength. The soil contains the nitrogen in an organic and insoluble form. From this store of nitrogen the soil prepares a little nitric acid daily, and it gives this small quantity of soluble nitrogen to the plant as a daily ration. The soil as it were *feeds* its plants, and that too with great caution." "It is otherwise when we give the plant nitrate of soda. We then set before it all at once the *full quantity of nitrogen*, which is intended to suffice for a whole summer, in a form which can be easily absorbed and at once disposed of. The plant is not nourished with nitrogen *by degrees*, the daily nitrogenous food is not *measured out* for it in small portions, but we leave it to the plant to take as much as seems good to it from the large supply at any time."

In spite of what we consider at times the radical defects in the reasoning of the author, through apparently ignoring certain effects which must influence results, and the rapidity with which he draws conclusions, we earnestly recommend this work to the careful perusal of all American experimenters at all interested in the subject of soil enrichment.

WISCONSIN, Fifth annual report of the agricultural experiment station of the university of. For the year ending June 30, 1888, pp. 184, plates 11. Madison: 1888.

To some stations we might commend the wise policy of the director of this station, as given in this report. "The station in planning its work has never attempted to cover but a very small portion of the field of agriculture, considering that it was far better to do a few things reasonably well than to attempt a great deal with the probability of accomplishing but little. We have endeavored to prosecute lines of investigation which seemed the most important, and to offer large prospects of usefulness."

It is generally known the country over that this station has not only done much practical, effective work, but that it has won the esteem and confidence of Wisconsin agriculturists. This we believe is due to the above policy.

The report under consideration in many respects is meritorious. The work done shows the intimate relations of science and practice, yet the expression is clear and plain enough for the perusal of fairly educated farmers. A practical discussion of the subject precludes and concludes the scientific data of most of the experiments. The tabular work is well arranged, with headings horizontal to the eye. Graphic illustrations are employed in order to effectively illustrate points of importance. There is no attempt to draw obscure conclusions through manipulation of figures. Finally, the work reported upon is practically important.

While it is not a matter of very great importance, it appears to us that the reports of the various members of the staff would look better, if grouped by themselves, instead of being distributed about in essay form. However, in the present arrangement there is the advantage of grouping allied subjects.

Most of the first 86 pages bear upon important experiments comparing ensilage with corn or corn fodder, both in feeding experiments, and from a chemical standpoint. Among others is a part of the paper published by Mr. Woll in this journal last year. Several feeding experiments on steers and pigs are recorded, the most valuable being on the effects of cornmeal, shorts and skim-milk on the carcass and internal organs of the hog, which is well illustrated by engravings from photographs. Dr. Babcock records some churning tests that yield important data. Mr. Short's new method for determining fat in milk, already noticed in this magazine (II. p. 215) is published here, and by the same writer is discussed the effect of dehorning milch cows on the production of milk and butter.

Not to reflect any discredit on other station reports, we believe this of Wisconsin to be highly commendable, and of a character and appearance such as indicates much work of important aims—a volume that can well be compared with that of any station in the country.

A BUSHEL OF CORN, by A. Stephen Wilson, 8°, pp. 346, ill. 6.
Edinburgh : David Douglass, 1883.

While this volume can hardly be called *recent* literature, it contains so much matter of interest, based upon experimental investigation, that it is worthy a notice here, for the volume is little known to Americans.

The book is the result of an inquiry begun in 1867. Originally the author intended only to test the popular belief in measure weight as an indication of the quality of oats. This investigation led to still others, till finally, 16 years later, is born this volume as a result of these inquiries.

Among the subjects discussed may be mentioned the following: The weight of a bushel of corn (embracing wheat, barley and oats). Diagrams of measure-weight of wheat, barley and oats. Measure-weight of grain in various localities and exchanges, such as Edinburgh, Haddington and Aberdeenshire. Measure-weight and degrees of ripeness, with a table of comparison of measure-weight and measure-number of several varieties of wheat at varying stages of ripeness. Classification of grain, especially oats. Percentage of kernel in oats wheat and barley in respect of measure-weight, embracing about 50 varieties of cultivated oats; also number of grains per pound, and the thickness of the husks of the different varieties. The percentages of kernel and outer coat in unripe wheat compared with the same in ripe wheat. Measure-weight variations under varying percentages of moisture in wheat, barley and oats. Doctoring measure-weight. Equivalents of different qualities of oats. Extremely interesting tables of various kinds are given, which indicate much laborious research.

Among all the books written on the cereals, of which we have reason to believe we possess an uncommonly extended acquaintance, we know of no one so entirely original in character, and so strikingly different from all others, as this one with the simple title, "A bushel of corn."

Though bound in quite plain cloth, the paper, print and workmanship are of such elegancy and character as would please the most fastidious bibliophile.

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## ABSTRACTS.

### A NEW DISEASE OF TULIPS.

(By DR. F. CAVARA : *Appunti di patologia vegetale*, 1888.)

The author, an assistant in the botanical institute of Pavia, Italy, gives an interesting account of a new fungus which he found seriously affecting the tulip. A beautiful collection of double tulips (*Tulipa gesneriana*, L. var.) which are cultivated in the botanical gardens of Pavia, have for some years been injured by a fungus which attacks the leaves and occasionally the stems and flowers, insomuch that it became necessary to renew the stock from time to time by fresh bulbs, a course, however, which has not always proved successful.

In the first stage of the disease, there appear scattered over both sides of the leaves, yellowish, depressed spots, which soon become irregularly oblong in outline, the longest diameter being in the direction of the veins of the leaf. Later, the spots lose their color and consistency, becoming whitish, membraneous, translucent and covered on the under side with a grayish mould that gradually extends over the surface causing the leaf to wither and dry up. Similar appearances also occur, though less frequently, on the stalks and parts of the flower; these organs may die, however, in consequence of leaf exhaustion without being themselves directly attacked.

The disease is due to a parasitic fungus, a Botrytis, as shown by microscopical examinations, experiments in the artificial reproduction of the disease, and in its development. * * * * * Sections through one of the diseased spots but on which the mould had not yet appeared, revealed under the microscope a much branched and septate mycelium occupying the mesophyll. * * * The mycelial threads are closely applied to the walls of the nourishing cells whose juices they absorb. * * * The spores of the parasite germinating on the surface of the leaf gain access to the interior tissues through the natural openings (stomata), and the fructifying branches pass to the lower surface through these openings. But one, or at most two branches issue from a single pore (stoma), a habit common to the other species of Botrytis. These branches are rigid, olive colored, thick walled, septate, and with swollen or ventricose basal segments. At their summits short, inflated secondary branches are developed, on which are borne the transparent or light gray, ovate gonidia. These latter have smooth, thick walls and a granular contents; they are relatively large, measuring 16–20 $\mu$ in length by 10–13 $\mu$ in breadth.

The germination of the spores was attempted in the following media: spring water; juice pressed from the stalks of the tulips mixed with water and filtered; fresh condensed natural juice; and boiled and filtered juice. In the spring water but few of the gonidia germinated and only after many hours (about 40), producing small bud-like growths whose development soon ceased. In fresh diluted juice a large number of the gonidia germinated in about 20 hours, sending forth short tubes giving rise to slender, sparingly branched mycelial threads producing a tardy fructification. In boiled juice all the gonidia germinated within six or eight hours, producing a more luxurious mycelial growth than in the last. In condensed and unfiltered natural juice all the gonidia germinated within two to four hours forming one to four small tubes, rapidly extending into a luxurious mycelial growth, frequently anastomosing, and producing gonidiophores.

Further, in all the experiments with condensed juice, after four or five days, when the substance became exhausted, the formation of sclerotia took place. These originated from the thin, sparingly branched and slightly varicose hyphæ, which became enmassed in a tangle or coil forming a small compact body which soon assumed on the exterior an intense brown color.

These sclerotia have a hemispherical or depressed globular form; covering the outside is a comparatively thin cortical layer; the interior consists of a white mass of entangled filaments with here and there an air cavity. In the dry tulip plants left on the ground, exposed to the the action of the weather, sclerotia were found exactly like those produced in artificial cultures. These bodies were particularly abundant in the petals, capsules and flowerstalks.

The microscopical examinations made indicated that the fungus was parasitic in its habits. Experiments were made, however, to produce the disease artificially, for it is known that many species of Botrytis are pure saprophytes living only upon plants already in a state of decay. Tulip leaves showing no indication of spots were selected and placed in the usual zinc chambers and over them were sprinkled drops of water containing germinating spores of the Botrytis. Within two days the characteristic yellow spots appeared where the drops had fallen, and soon the gonidiophores appeared on the under side of the leaves. This experiment was repeated several times and always with the same result. Sections made through the inoculated points revealed under the microscope a mycelium having all the characteristics of that found in leaves from naturally infected plants.

There can be no question then as to the fact that the *Botrytis* causes the disease.

No remedy, other than that of renewing the stock with fresh and healthy bulbs, is suggested.

There is no record that this malady of tulips has yet appeared in this country but the introduction is possible and owing to its evident serious character the florist should be able to recognize and if possible suppress it, or at least prevent its general distribution.

F. L. S.

## BLACK ROT (*LÆSTADIA BIDWELLII.*)

(By SCRIBNER and VIALA: *Bull. 7, U. S. dept. agr., botan. div.*, 1888.)

It is thought best to give some data from this interesting bulletin, additional to that published in this magazine at various times during 1888.

Black rot occurs over the United States east of the Rocky mountains on all wild and cultivated vines. California is exempt at present. And likewise New Mexico, Arizona, Colorado and Utah. It is especially destructive in states bordering the Atlantic, the great lakes and Gulf of Mexico.

Black rot is the most serious and important disease of the vine in the United States. On account of it, it has been impossible to grow the finer sorts of grape in the Carolinas, Georgia, Alabama, Mississippi and Louisiana. Oftentimes the disease is so severe as to destroy the entire crop. European vines are the most subject to the malady.

All hybrids of *Vitis vinifera* are especially susceptible to this fungus. The following varieties cannot be utilized owing to black rot, *i. e.*, Othello, Triumph, Brant, Canada, Black defiance and Secretary. Prentiss, Bacchus, Pocklington, Peabody, Rogers' hybrids, Rickett, Niagara and Catawba some seasons lose their whole crop. Cynthiana or Norton's Virginia is the least subject to black rot of American varieties. The Herbemont is nearly as resistant.

The conditions specially favoring the development of this disease are warmth and moisture. Where the summers are warm and dry, as in Arizona, it does not thrive. In localities of high altitudes, where dews and mists are rare, as at Hammondsport, New York, on the hillsides, little damage is done. The parasite requires precipitated water for its dissemination.

Black rot is of American origin, and was conveyed to Europe from this country in 1885. The earliest reference to this disease was in 1848, although in a vague sort of way. The oldest specimens of the fungi extant are in the Curtis herbarium of Harvard university, and were collected in 1850, and were named *Phoma uvicola* by Berkeley and Curtis. The perithecia of *P. uvicola* were first discovered by Mr. Bidwell in New Jersey, and Prof. J. B. Ellis named this form *Spæhria Bidwellii.* Saccardo later christened it *Physalospora Bidwellii.* The authors, after carefully studying it in America and France, have named it *Læstadia Bidwellii.*

Black rot attacks by preference, young, tender leaves, especially those at the ends of branches, and always begins by attacking the leaves. As soon as the parenchyma becomes firm, the spots are very limited in size, and the leaves do not seem to suffer. Leaves may be attacked at the commencement of vegetation; they are generally affected a month or three weeks before the disease appears on the berries. The exact time for the appearance of the rot on the leaves, varies according to the different states, and depends upon the temperature and moisture. The berries of late varieties, like Æstivalis, are not actually attacked much before ripening. There are generally two periods of invasion: the first is usually mild, and coincides with the flowering of Æstivalis, the time when berries of Labrusca and its hybrids are forming; during this period a third or more of the crop may be destroyed. About the beginning of July comes a period of rest; later in the month, about the first of August, black rot develops on the berries very rapidly, and may destroy the whole crop in eight days. In warm, moist regions the berries become soft and juicy, and the skin is as black as ink, does not wrinkle, and is studded with innumerable small pustules. The diagnosis applies to France as well as the United States.

The spermagonia are only formed during the first stages in the development of the rot, their special rôle probably being that of spreading the fungus during its period of activity. They are sometimes produced under special conditions, and on rotting, juicy berries is frequently found only spermogonia. At other times black juicy berries may have all their pustules transformed into sclerotia, they being more numerous at the end of vegetation, both on berries on the ground and those on the vine. Similar sclerotia have been found in June on berries of the preceding year; in artificial cultures they produced conidia-bearing filaments. The rôle of the sclerotia is not yet determined. The stylospores and spermatia are usually enclosed in separate receptacles. The pycnidia are the most important organs in the reproduction, and appear soon after or with the spermagonia, forming during the fall and winter to the next period of vegetation. The stylospores are discharged through an opening (ostiolum) at the apex of the pycnidium, as a continuous and twisted white thread, which in warm, moist weather are discharged, and the berries become studded with them. If the weather remains dry, the united stylospores are separated more or less by the wind, so that the parasite may thus be carried from leaves to fruit. If a thread is kept very dry, it will finally disintegrate, and in water at 25° C. the oily material will separate, and the spores germinate. But if the water is removed they will not germinate, but may be kept a long time without losing vitality. These threads, in damp air, away from water, will swell in five or six days, and the stylospores on the surface begin to germinate.

Berries turned brown by black rot, containing the characteristic mycelium, without conceptacles, in a damp sterilized atmosphere at a temperature of 30° to 35° C. developed pycnidia in five to six days. During the development of pycnidia, the basidia swell at their free ends, forming little expansions, which are rudimentary spores, that in time acquire normal size and shape, and become densely packed in the center of the conceptacle.

The mature reproductive bodies of black rot are found fully developed only in May or early June. In American vineyards, the grapes destroyed by rot eventually come to the ground, and on them the perithecia are formed, where their pustules may be seen with the naked eye, being more prominent and darker than those of pycnidia. They are at first imbedded in the fruit, but emerge during their growth, rupturing the dried cuticle.

The general structure of the perithecia resembles that of the conceptacles, and are generally formed at the expense of the tissues of pre-existing pycnidia. The asci spring from the bottom only of the perithecium, from a stroma composed of a fine, colorless and shining mycelium, are as long as the perithecium is high, and stand parallel to each other; their number varies from 40 to 120 in each perithecium. In shape the asci are cylindrical, conical, expanded above, abruptly tapering to a narrow base, and have thin walls and are filled with a finely granular, homogeneous protoplasm from which the ascospores are differentiated. These swell up in water, and the walls thicken and undergo gelification, but do not become mucilaginous, and are hygroscopic. The sporidia are then perfectly developed and enclosed within the ascus, being colorless, subovoid and a little depressed on the sides, with thin walls, containing finely granular protoplasm.

When dew penetrates the perithecium through the large top opening, the walls of the asci swell up, frequently rupturing the perithecium at the ostiolum, where the asci are discharged in whole or part. The escaped asci contain ascospores, which they expel. Ascospores were inoculated on healthy leaves, on the vine, and reproduced black rot spots with the characteristic pustules. When the asci have discharged their spores, their wall rapidly disappears.

## CONCERNING FAT DETERMINATION.

### FAT DETERMINATION IN LINSEED CAKE.

(By DR. P. BAESSLER : *Landwirth, Versuch-Stationen*, xxxv, p. 341.)

Attention has been called to the necessity, in fat determinations, of previously drying the material at 100°C. and employing water-free ether. The author encountered variations in results obtained by this method particularly with linseed cake, which were not easily explainable. In one case cited, duplicate samples of linseed cake dried as usual yielded 13.49 and 13.63 per cent. of fat, while a third sample of the same material dried an unusually long time by accident, gave only 6.58 per cent. The method followed was, drying 6–8 hours at 100°, and then extraction with ether in Soxhlet's apparatus for 12 hours. Under the assumption that a portion of the linseed fat undergoes change by longer or shorter heating at 100°, some comparative determinations were made in which samples which had been dehydrated by standing over sulfuric acid were taken as standard.

| | I. | II. |
|---|---|---|
| 72 hrs. in vacuum with sulfuric acid.................................... | 7.69 p. ct. fat. | 9.96 p. ct. fat. |
| Air dry condition.................................... | 8.02 " " | 10.34 " " |
| After 6 hrs. at 100°.................................... | 3.74 " " | 7.70 " " |
| After 10 hrs. at 105°.................................... | 2.56 " " | 5.41 " " |

That is, a continuation of high temperature occasioned very decided losses in the amount of fat. Remembering, however, that the latter consists largely of linseed oil, one of the drying oils, changing quickly on exposure to air or heat, this loss is not strange. The process is one of oxidation and formation of ether-insoluble resinous bodies. In this case, drying in a stream of air must result, on one side, in a loss of water, and on the other in an increase of weight of the fat itself. This the author proved by actual experiment; 6.282 grams of air-dry linseed cake over which dry air was conducted at *ordinary temperature* during 24 hours, yielded up 0.3171 gr. of water and increased in weight itself 0.0295 grams. The progress of the change as indicated by the following data, was interesting:

| | Loss of sub. in vol. matter. | Increase of wt. in $CaCl_2$ tube. | Increase of wt. of sub. |
|---|---|---|---|
| After 3 hrs. heating...... | 0.4905 | 0.5360 | 0.0455 |
| " 6 " " ...... | 0.5045 | 0.5550 | 0.0505 |
| " 9 " " ...... | 0.5075 | 0.5650 | 0.0575 |
| " 12 " " ...... | 0.5090 | 0.5700 | 0.0610 |

In a second experiment 8.1261 gr. of air-dry linseed meal, *heated* during 6 hrs. at 100°, gave off 1.0100 gr. of water, and took on 0.1134 gr. of weight, or 1.40 per cent. of the original substance. In both experiments certain oily drops were carried over into the bulb of the calcium chloride tube, which were partially soluble in ether. Their appearance indicates therefore that moisture determinations of linseed cake made by either the above methods are not wholly correct.

If the increase in weight of the substance is due to oxidation of the fat, then drying in a hydrogen current would avoid the same. This was proved by experiment; 8.6430 gr. air-dry linseed meal were heated for 6 hrs. to 100° in a current of hydrogen, by which 1.0200 gr. of water were driven off and the substance lost in weight 1.0205 gr. The residue yielded 10.00 per cent. of fat, corresponding to that found after drying over sulfuric acid (9.96). Following are the conclusions drawn from the investigation:

1. Fat determinations in linseed cake (or meal) made in the usual way (dried at 100° and extracted) give unreliable results.

According to circumstances the values obtained may be five per cent. too low.

2. This error is based on the transformation of the fats by oxidation into substances insoluble in ether. Also a certain volatilization of fats may occur.

3. Better results may be obtained: by drying the material over sulfuric acid, or in a current of hydrogen at 100°, and the extraction of the material thus prepared, with water-free ether.

### METHODS OF FAT DETERMINATION.

(From proceedings of the association of German agricultural experiment stations, Sept., 1888, *Landwirth. Versuch-Stationen*, xxxv, p. 437.)

Coöperative tests upon methods of fat determination were reported upon, the results being expressed as follows:

1. The amounts of ether extracts from various fodders were always decidedly lower when the substance was dried at 100°, and the ether was quite water-free, than when air-dried substance and ether containing water were used.

2. The excess of the extract obtained by watery ether from air-dried substance, over that derived from dried material with water-free ether, consisted mostly of bodies of an acid reaction, soluble in water and not to be regarded as fats or the higher fatty acids.

3. By long continued extraction with watery ether, a much larger product is obtained, but the increase consists almost wholly of acids (lactic acid).

4. Since linseed cake contains drying-oils it is necessary to use great caution in drying the same. The temperature should not exceed 100°, lest a change of the fats into a form insoluble in ether results. An increase of temperature above 100° in drying, decidedly decreases the amount of ether extract; on the other hand the commission found that cautious drying below 100°, did not cause a decrease in the amount of ether-extract.

5. Some tests were also made of the efficacy of carbon-bisulfide, as an extracting agent with results agreeing closely with those obtained with ether. It is necessary, however, that the material and the carbon-bisulfide be water-free, just as in the case of ether.

The recommendations of the commission were as follows:

*a.* It is unconditionally necessary that fodders be thoroughly dried before being subjected to a fat determination. On account of changes occurring in some substances the temperature for drying should never exceed 100°. Three hours drying at 95°C. is proposed as a general rule. With linseed cake drying in a current of hydrogen or illuminating gas seems feasible.

*b.* The ether used for extraction should be perfectly free of water (by use of sodium) and alcohol.

*c.* If carbon-bisulfide is used in place of ether, it must be water-free as well as the substance itself. W. E. S.

## CONCERNING THE PRESENCE OF FIBRIN IN MILK.

(By S. M. BABCOCK; *Proc. soc. for the prom. agr. sci.*, 1888, pp. 13–17.)

The author believes analytical evidence is that the albuminous matter of milk is concentrated near the fat globules, and carried by them into the cream. Analyses almost invariably show more nitrogen in cream than skim milk, when referred to water content. If this concentration is caused by a true membrane, or a natural affinity of fat for albuminous matters, forming a *haptogenic* membrane by resting on the surface of the fat globules, its amount should have some relation to the amount of fat in the milk, and should be evident in all milks containing different amounts of fat. That this is not the case can be seen by comparing milks, *i. e.*, the first and last milk drawn from a cow at any milking, where the amounts of fat strikingly differ, even though the animal has the same diet. A large number of such milks show practically no difference in nitrogenous matter when referred to water content, which indicates clearly that, when first drawn, the albuminous matter of milk is in perfect solution, and equally diffused through the milk serum, with an independent distribution. If so, the accumlation of nitrogenous matter in the cream is caused by changes in the milk after it is drawn. It is to the changes the author directs his attention.

Dr. Babcock first considers microscopical differences between milk and artificial emulsions. In a perfect emulsion formed from a pure fat and filtered solution of an alkaline albuminate, or other suitable emulsifying agent, the fat globules appear quite evenly distributed, with little tendency to grouping. Milk when first drawn has almost identically the same appearance; in a few minutes, however, fat globules will begin grouping, appearing held together by some gelatinous matter strong enough to keep them in the same relative positions. The number and solidity of these groups increases rapidly, and are much more marked in cream than skim milk. Probably they are caused by spontaneous coagulation of albuminous matter in the milk, which entangles the fat globules and forms the groups. This is confirmed by analyses. The only nitrogenous principles which possess this coagulation, are blood fibrin and its analogues.

The most characteristic property of blood fibrin is that of spontaneous coagulation soon after the blood is drawn from the veins. This fibrin is a product of the decomposition of the blood plasmine. Agitation or exposure to air hastens coagulation, and the clot attaches itself to any rough surface or foreign body, especially if in motion, and coagulates more rapidly in shallow than in deep vessels, the clot first forming at the surface and sides of the vessel. Certain warmth hastens coagulation, cooling retards and rapid freezing prevents. Many chemical substances retard or wholly prevent coagulation, as dilute solutions of soda, potassa, and ammonia, and their carbonates and chlorides. Fibrin in this form is insoluble in water, alcohol and ether; soluble in dilute caustic alkali solution and very dilute acetic, muriatic and phosphoric acids. Treated with neutral soda, potassa and magnesia salts, it swells up forming a jelly and apparently dissolves, though unevenly; decomposes rapidly in air, becoming soluble in hot water and is converted into a substance which like albumen, is coagulated by heat; during this process oxygen is absorbed and ammonia, carbonic acid and butyric acid developed. By solution in dilute acids it is converted into acid albuminate or syntonin. This fibrin rapidly decomposes peroxide of hydrogen though not if first heated to nearly boiling. If, before treatment with peroxide of hydrogen, it be moistened with guiacum tincture, it changes to deep blue.

Nearly all the direct fibrin tests are common to all protein bodies, and are not adapted to milk. The power of decomposing hydrogen peroxide is quite characteristic, and not shared by any other substance likely to be found in normal milk. The test method was to add a small quantity $H_2 O_2$ to fresh milk, and then test this milk at intervals to see if the peroxide has disappeared, and in any case in a short time it was decomposed with slight oxygen effervescence.

New fresh milk is more active than when standing for a time, and in two or three days, acts very slowly. Cream is much more active than whole milk, and skim milk hardly none at all. When sweet cream is treated with a mixture of alcohol and ether and filtered, the residue decomposes the $H_2 O_2$ rapidly, and if first moistened with guiacum tincture is colored blue, though this latter test is not applied to milk directly; but if filter paper is moistened with milk and dried, it will shortly give a blue tint if tested. Milk heated to near the boiling point, loses its power of decomposing $H_2 O_2$.

If the grouping which takes place in the fibrin is caused by coagulation of a substance analagous to fibrin, the addition to the perfectly fresh milk of substances which prevent the coagulation of fibrin should prevent the aggregation of fat globules. A solution of sodium or potassium hydrate, added to milk, in one-tenth per cent. prevented grouping even after 24 hours. Potassium nitrate and some other neutral salts have a similar effect, but not so actively so, as there is a slight tendency to grouping, but the clots have little consistency, and the globules are to some extent free to move. Any substance added to blood which will prevent its coagulation, will at the same time prevent blood corpuscles grouping.

Fibrin causes the globules to rise slowly when entangled in its clots, as they carry the clots with them, and clots containing but few globules will not rise at all; consequently, conditions unfavorable to fibrin coagulation, should facilitate creaming of milk. Methods of creaming in use substantiate this, and explain why delayed setting, or disturbing of milk after setting, gives a small proportion of fat in the cream. The aeration and agitation given milk in the centrifugal, coagulates the fibrin immediately, largely separates it from the milk and deposits it upon the centrifugal drum, as is shown by tests with $H_2 O_2$ and tincture of guiacum. Cream is also less active when from the centrifugal, than from Cooley cans, though it contains considerable fibrin, the skim milk having almost none.

Fibrin in cream probably renders churning difficult, and fat recovery imperfect. The beneficial effect of ripening cream is doubtless due to fibrin decomposition, which is greatly promoted by exposure to moderately warm temperature and air. The process is completed by the acid developed, which destroys the fibrin. Lactic or acetic acid added to cream in proper quantity will facilitate churning without loss. When unripe cream is churned, butter is lost and most of the fibrin adheres to the butter fat and is retained in the butter. If butter from sweet cream be melted and filtered, the residue freed from fat by ether and tested for fibrin, it will give all the reaction, while butter from ripened cream, treated the same, will give no reaction. Butter containing fibrin, if exposed to air, becomes bad, as the fibrin decomposes and sets free ammonia and butyric acid, both characteristics of rancid butter. Centrifugal slime quickly acquires butyric acid odor.

Spontaneous coagulation of milk, without acid development, the author believes is caused by an abnormal amount of fibrin.

While the quantity of fibrin in milk is very small, there is no satisfactory method of determining the exact amount. Blood is supposed to contain about three-tenths per cent. of fibrin, and milk Dr. Babcock does not think contains more than .003 per cent. or less perhaps.

## ANALYSES OF SOME SOUTHERN FRUITS WITH REFERENCE TO THEIR FOOD VALUES.

(By CHARLES L. PARSONS : *Amer. chem. jour.*, x, pp. 487–88.)

König in "Nahrungs-und Genussmittel" gives many fruit analyses, but only one analysis of oranges is given. The author gives analyses of oranges, pomegranates, persimmons, bananas, bread and cocoanuts. The oranges were received fresh from the Florida grove, each specimen being wrapped in tissue paper. The pomegranates and persimmons were obtained from Hawkinsville, Georgia. For the analyses a number of oranges were taken of each variety ; total acids and water determined in an average sample of the fresh fruit, and the remainder of the pulp dried at about 95°C. The pomegranates and persimmons were treated in the same way, with the exception that the pulp of the persimmon was separated from the seed by means of a large-meshed seive, previous to drying. The Navel orange is selected as a type of the Florida oranges, and the Guy Pope, a Messina orange, a type of the Mediterranean oranges ; this in comparing dry substances of the fruits analysed, with the dry substance of bread, cocoanut and banana, their nutritive ratio and number of food units.

Below are the averages of the analyses :

| | $H_2O$. | Crude protein. | Free acids. | Glucose sugar. | Cane sugar. | Ether extract. | Crude fibre. | Ash. | Albuminoid nitrogen. | Nitrogen free extract. |
|---|---|---|---|---|---|---|---|---|---|---|
| Sweet pomegranates | 78.27 | 1.33 | .368 | 11.61 | 1.04 | 1.24 | 2.63 | .761 | .177 | 15.77 |
| Sour " | 75.41 | 1.60 | 1.85 | 10.40 | .26 | 2.05 | 2.83 | .544 | .203 | 17.57 |
| Persimmons.... ........ | 66.12 | .827 | .000 | 13.54 | 1.03 | .701 | 1.78 | .861 | | 29.71 |
| Florida orange, Bitter sweet.... | 86.86 | .815 | .417 | 5.71 | .84 | .243 | | | | |
| Florida orange, Tangerine ...... | 83.56 | .792 | .477 | 6.00 | 3.41 | 2.56 | | | | |
| Florida orange, Mandarin. ..... | 79.95 | .834 | .855 | 4.77 | 8.07 | .146 | | | | |
| Florida orange, Bloods............ | 85.57 | .700 | .670 | 5.70 | 3.94 | .100 | | | | |
| Florida orange, Navels............ | 83.70 | 1.12 | .662 | 6.03 | 4.68 | .234 | | | | |
| Florida orange, Russets.......... | 83.18 | .905 | .817 | 7.29 | 4.51 | | | | | |
| Florida orange, Common........ | 86.58 | .862 | .756 | 4.60 | 4.38 | .076 | | | | |
| Florida orange, Sour.. ............ | 86.76 | 1.03 | 2.55 | 3.86 | .97 | .125 | | | | |
| Messina orange, Guy Pope....... | 86.22 | .980 | 1.18 | 5.95 | 1.82 | .166 | | | | |

| | Ntg.-Protein. | Fat. | Nitrogen-free extract=N. Ntg. | Nutritive ratio. Ntg : N. Ntg + (1¾ × fat) : : 1 :— | Food units in 1 kilo: Ntg : fat : N. Ntg : : 5 : 3 : 1 | Nutritive ratio—Ntg : : N. Ntg. + (fat × 1.75) : : 1 :— |
|---|---|---|---|---|---|---|
| Bread.................................. | 10.94 | 87.97 | .71 | 8.7 | 1446.2 | |
| Sweet pomegranate............ | 6.12 | 72.52 | 5.70 | 13.5 | 1202.2 | |
| Sour " ............ | 6.50 | 71.44 | 8.34 | 13.4 | 1289.6 | |
| Persimmons......................... | 2.44 | 90.63 | 2.07 | 38.6 | 1090.4 | |
| Banana... ....... ......... ........ | 6.94 | 85.72 | 2.33 | 12.9 | 1274.1 | |
| Solid portion cocoanut.. .... | 10.31 | 15.10 | 67.33 | 12.9 | 2686.4 | |
| Mandarin orange................ | 4.15 | 85.88 | .73 | 21. | 1088.2 | |
| Navel orange ...................... | 6.87 | 80.85 | 1.44 | 12.1 | 1195.2 | |
| Guy Pope orange................ | 5.78 | 71.11 | 1.22 | 12.7 | 1036.7 | |

These analyses of Florida oranges indicate that the best varieties contain the highest percentage of cane sugar, and that superior flavor and contents of cane sugar run in nearly parallel lines.

## AGRICULTURAL SCIENCE NEWS.

There are 59 agricultural schools in Ireland, with the same number of teachers.

Mr. Ralli of Liverpool, England, has offered to give $1,500. toward establishing a dairy school in Flintshire, Wales.

Dr. W. E. Stone contributes an interesting illustrated article to the *Botanical gazette* (xiii, 11) on botany at the university of Göttingen.

The Vermont legislature appropriated $6,000. for the state agricultural college, for the next four years, $3,600. being for a professorship and $2,400. for scholarships.

A marble bust of the late Prof. John Wilson, formerly professor of agriculture in the university of Edinburg, Scotland, has just been presented to the university by his widow.

The United States secretary of the treasury has decided that the oleomargarine law covers the use of butter coloring, and that a butter which is colored is practically speaking an adulterated article.

According to the *North British agriculturist* (Nov. 14, '88) the officials of the Odessa bacteriological station sent to a land owner, for purposes of protective inoculation, a lymph of greater potency than was ordered, for out of 4700 sheep inoculated, 4400 died within 12 hours after inoculation.

The U. S. commissioner of agriculture has appointed Prof. Wm. H. Welch of Johns Hopkins university, Dr. E. O. Shakespeare of Philadelphia and Prof. T. J. Burrill of Illinois university, a commission to investigate the subject of swine diseases in the United States, the methods of its treatment and prevention, etc.

The cause of "mal nero" or gummosis of the vine has been studied by Sig. O. Comes, according to *Revue mycologique* (1888, p. 165) who finds it to be characterized by the presence of brown corpuscles in the amyliferous parenchyma, which he regards as produced by gummy degeneration of the starch-bearing cells.

Bulletin two of the division of economic entomology of the United States department of agriculture deals with bird migration in the Mississippi valley in the years 1884 and 1885, and is by W. W. Cook. We cannot see that the volume has any special agricultural bearing, being strictly ornithological matter.

Prof. J. H. Comstock makes a note in the *American naturalist* (Nov., 1888) of a case of plum curculios making pits from one-eighth to one-fourth inch in diameter, puncturing apples. The serious injury done to an apple orchard led him to place some apples in a cage with the curculios, who ate the apples similar to those noted in the orchard.

According to *Comptes rendus* (Nov. 20, 1888) A. Béchamp concludes that milk is not an emulsion. The milky globules are not bare globules of fat, but true free adipose vesicles. The milk of the cow contains, in addition to casein, other albuminoid matters not free, but dissolved in combination with alkalies. Milk curdles spontaneously without the intervention of vibrios.

P. Magnus describes a number of instances (*Botan. Central.*, xxxiii, p. 62) where fungi were unable to produce spores, and developed in a monstrous fashion away from light. The lack of nutriment acts the same. The author quotes a remarkable case of mushroom development in Berlin, as the result of overmanuring, the bodies externally resembling in general, sclerotia, but resembling in structure the receptacles of subterranean Gasteromycetes, in which the formation of the gleba has been suppressed.

The November and December bulletins of the Royal gardens, Kew., contain matter of much economic interest. The November bulletin, contains articles as follows : Lagos rubber ; Liberian coffee at the Straits Settlements ; tea oil and cake ; Demerara pink root ; food grains of India (continued); Yoruba indigo ; Trinidad ipecacuanha ; treatment of vines in France ; huskless barley ; Ramie. The contents of the December issue are Inhambane copal ; the cultivation of Rice in Bengal ; silkworm thorn ; Jamaica India rubber ; seedlings of sugar cane at Barbados ; Ramie.

The scientific committee of the Royal horticultural society of England tested at the Chiswick grounds the high moulding system for the prevention of the spread of potato rot. Two rows were tested side by side, each 300 yards long, of the same variety—Schoolmaster. One row was moulded in the ordinary way, while the other was high moulded (ridged), one side being banked up, while over the other side the haulms were laid. One hundred potatoes were examined in each row, indiscriminately, and 26 per cent. of the ordinary culture were effected, while not ten per cent. of the high moulded were diseased.

The Belgian government takes much interest in agriculture. During 1888 the government appropriated nearly $425,000. for agricultural purposes. A system of free lectures was also carried out, and 1575 lectures were delivered in 1887. Fruit growing and market gardening were the subjects of 1140 of these lectures, 12 were on forestry, six on tobacco, 298 on veterinary science and zoötechny, 44 on dairying, 64 on farriery and 11 on bee culture. The lecturers were practical farmers, foresters, nurserymen, gardners, veterinary surgeons and professors in the state schools. Experiments are carried on under a superintendent in each district.

## EXPERIMENT STATION ITEMS.

Bulletin 81 of the California station gives a list of the plants and seeds to be distributed by that institution.

The third bulletin of the Florida station gives the results of fertilizer experiments on corn. A few notes are also given on grasses and corn.

The fifth bulletin of the Colorado station is largely devoted to informing as to what will be done at that institution, with a brief report on the apiary.

Bulletin 36 of the Ontario department of agriculture, coming from the agricultural college, is by Prof. Panton, and is about rust, *Puccinia graminis*. It gives no original research.

Bulletin three of the Texas station gives brief field notes of a number of grasses and forage plants being tested at that station. The notes are generally quite incomplete.

The subject of grapes and strawberries occupy the space of bulletin seven of the Arkansas station. The data simply deal with the growth of varieties of plants, they being too young to produce fruit.

Dr. A. T. Neale, for several years past chemist to the New Jersey agricultural experiment station, has been elected director of the Delaware experiment station, beginning work there January first, 1889.

The experimental barn of the Ontario agricultural college, at Guelph, was burned on November, 26, 1888, the loss amounting to $30,000. No stock was lost. The barn was new, the college three years ago having undergone a similar experience.

"Analyses and valuations of complete fertilizers, ground bone and miscellaneous samples of other fertilizing materials," is the title of bulletin 49 of the New Jersey station. It is very largely tables of analyses, etc.

Bulletin 59 of the North Carolina station gives some interesting data regarding seed germination, and shows that considerable poor seed, badly adulterated, is sold in that state. If, however, but 100 seeds of a variety are tested, as the bulletin indicates, it is hardly fair. The average of ten lots of 100 each might make a quite different showing.

Prof. W. O. Atwater has been placed in charge of the bureau of correspondence to be established at the department of agriculture, at Washington. This bureau is to enter into correspondence with the various experiment stations, with the view of generally distributing information concerning the work done by the stations of America and Europe. It is stated by the press that specialists will compile articles about which information is needed, for general dissemination.

The first bulletin of the Oregon station deals with history and organization. It is located with the state agricultural college, and has but 35 acres of land available. The following is the staff: E. Grim, director; E. R. Lake, agriculturist and botanist; P. H. Irish, chemist. Some of the proofreading in this bulletin is inexcusable, as for example, under list of officers, is the appellation, "Hortoculturalist," and over it "Agriculturalist," which Webster says "is improper and unusual."

Bulletin 16 of the Louisiana station relates to vegetables and grains, the plants tested being potatoes, tomatoes, peas, wheat, buckwheat and barley. The results are very much injured through drought, chickens and failure. The 17th bulletin of this same station is on ensilage. A silo was made at the station, by digging in the bank of the bayou, the pit being 8 x 10 x 12 feet. Corn was cut into this, and well preserved. A large share of the bulletin is devoted to analyses of samples.

Bulletin two of the Alabama canebrake station describes experiments with cantaloupes, tomatoes, Irish potatoes and fruit trees. Of cantaloupes, pine-apple possessed the highest flavor, and Bay view was first in size and productiveness. Of tomatoes Early advance proved most prolific. A test of keeping qualities of Irish potatoes was made, being preserved under different circumstances. The effects of cultivation vs. clover sod on young fruit trees of apple and peaches, gave a very much increased growth of the trees on cultivated soil.

The second bulletin of the Maryland station, a most creditable affair, in arrangement and contents, is mainly devoted to a report on "cutting seed potatoes for planting." Sixty-two standard varieties were used in this experiment, and five different methods of planting adopted. A represented one large tuber per hill; B a potato the size of a hen's egg; C one-fourth average size potato; D single eye on large piece of potato and E, single eye on small piece of potato. For each variety five rows were used, three feet apart with four hills per row, each two and a half feet apart. The result showed that the greater the quantity of seed potato used, the greater was the product.

The third bulletin of the university of Illinois station reports a series of oat experiments, and tests of grass and clover seed. In quantity of seed per acre, 2.5 bushels gave the greatest weight of grain, and three bushels of straw. A medium loose seed bed yielded more grain and straw than one compact or very loose. Seed sowed April 6 made a better showing than that sowed April 13, 20 and 27. In depth of planting three inches gave most vigorous plants, though not the earliest to mature; the yield was very variable from one to five inches deep. Observations on the germination and stooling are added to these experiments. Twenty-one varieties of seeds of grasses and clovers were tested in a Geneva germinating apparatus, of which less than 41 per cent. germinated the first week, and during the following 12 weeks about seven per cent. more germinated.

Bulletin 14 of the New York station, at Geneva, is on the chemical composition of some feeding-stuffs. Certain chemical terms are defined in explanation of those used. Following these are analyses and brief notes upon *Phleum pratense ; Dactylis glomerata ; Poa pratensis ; Avena elatior ; Alopecums pratensis ;* mixed grasses ; *Trifolium pratense ; T. hybridum ; Medicago sativum ; Symphytum asperrimum ; Zea mays ;* maize fodder, and ensilage ; oat and wheat straw and maize stover ; maize as starch feed, hominy feed and gluten meal ; wheat ; oats ; tubers and roots ; linseed and cotton seed meals. With all of these the chemical composition and ash analyses are given, and the digestibility of numerous others.

Bulletin four of the Minnesota station is of interest. Experiments are recorded of the comparative value of cold and warm water for stock, the respective temperatures being 32° F. and 70° F. Better results were secured from the cold water, than the warm. The effect of this water was also noted on food consumption and milk, butter and beef production. In all this work, the results were not what is generally supposed will ensue, as the variation between the two groups was slight, though usually favoring the use of cold water. In this same bulletin, the entomologist writes of "fungi which kill insects," and especially those affecting the chinch-bug and locust ; the article is admirably illustrated. This work is mainly compilation. "Tuberculosis, tubercular phthisis or consumption in animals" is the subject of a paper by the veterinarian in this bulletin.

Bulletin 17 of the Wisconsin university station relates to corn, oats, barley, potatoes and grapes. Of dent corns, Pride of the North, North star golden dent and Queen of the north are the only ones recommended. King Phillip has no superior there among the flints. Of the sweets, Cory, Early LaCrosse and Early Narragansetts are earliest, in order named. White Schoenen oat is placed at the head of the list. Swedish, Welcome, White bonanza, Early Dakota white and American banner oats are favorably mentioned. Of barley, the Manshury is specially commended, of ten varieties tested. Sixty-eight varieties of potatoes were tested, and the following recommended : Pearl of Savoy, Beauty of Hebron, Crane's June eating, for early ; Summit for medium or late. Director Henry makes an appeal to Wisconsin farmers to produce their own grapes, and gives advice as to how to do so and reports on the station vineyard. Three excellent engravings of photographs of scenes in the station vineyard are given.

The second bulletin of the Storrs' school station, contains an interesting experiment on the comparative effects of tilling vs. not tilling the soil, in loss of moisture by evaporation. Eight cans of galvanized iron, 30 inches deep and ten inches in diameter were filled with soil. Two classes of soil were used, four cans per each lot, one soil being heavy loam with clayey subsoil, and the other light loam with a sandy subsoil. The surface soil in two cans of each lot was stirred frequently, one to a depth of two and the other four inches, while that in the other cans was left undisturbed. The cans were buried in soil, in the field, and so arranged that an accurate record of loss of moisture could be kept. For 16 days a record was taken, and the figures are as follows, explaining themselves :

LOSS BY EVAPORATION FROM AUG. 15–31.

| Condition of surface. | Lot I. Heavy soil. | Lot II. Light soil. | Lot I. Heavy soil. | Lot II. Light soil. |
|---|---|---|---|---|
| Not stirred | 4 lbs. 13.0 ozs. | 3 lbs. 5,0 ozs. | 1.69 inches. | 1.16 inches. |
| " " | 4 " 9.0 " | 4 " 2.5 " | 1.62 " | 1.46 " |
| Stirred 2 in.* | 3 " 10.5 " | 1 " 12.5 " | 1.29 " | 0.62 " |
| " 4 " * | 3 " 8.0 " | 2 " 3.0 " | 1.23 " | 0.77 " |

*Stirred every alternate day, unless prevented by rain.

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# LUPULIN—CONDITIONS OF FORMATION AND A METHOD FOR DETERMINATION.

BY H. E. STOCKBRIDGE.

Lupulin formation in hops, the conditions modifying its production, and the methods for its analytical determination, have been the subject of investigation and experiment by the writer for the past three years, and the results have in a great measure already been published.[1] But certain facts have developed of such a nature as to induce me to make them public here rather than through the means of official publication.

The wild hop is a native of most parts of northern Japan and grows with such luxuriance as to naturally suggest hop cultivation as an industry peculiarly fitted to the Hokkaido.[2]

Indeed in external appearance the wild product is little inferior to the best cultivated varieties. Analysis, however, shows it to be of marked inferior quality.

COMPOSITION OF HOKKAIDO WILD HOPS.

| In dry sub. | Organic matter. Per cent. | Ash. Per cent. | Alcohol extract. | Water Ex. from alcoholic residue. | $K_2O$ in ash. | $P_2O_5$. |
|---|---|---|---|---|---|---|
| | 81.66 | 7.12 | 22.72 | 13.82 | 36.25 | 13.83. |

The inference, however, was natural that where the wild plant throve as an indigenous product, the improved cultivated varieties must find a congenial habitat. Unfortunately, therefore, measures were several years ago taken to follow up the supposition without sufficient and careful investigation of all the conditions essential to the success of a new industry.

In its endeavors to open up the country and furnish new channels for industry, aided doubtless by a desire to diminish the consumption of *saké*, brewed from rice, the government invested hundreds of thousands of dollars in an endeavor to establish hop-growing and beer-brewing as a permanent industry, only to find, notwithstanding the introduction of the best imported varieties of hops and foreign machinery and appliances of all kinds, that after two years of limited success, absolute failure ensued. The beer produced being deficient in the aroma and bouquet of the genuine product, and utterly lacking the essential keeping qualities.

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[1] Report of the chemist to the Hokkaido cho for the year 1887.

[2] The Island of Yesso, occupying one-third the area of the Japanese Empire, constitutes the governmental dept. of the Hokkaido.

This was the condition of the industry when my connection with the case began.

The fact that for the first two seasons operations were measurably successful, and that no change in processes had been made, immediately led to the surmise that the difficulty was in all probability due to a change in the composition of the hops used through change of habitat and subjection to new and different climatic influences.

Numerous analyses of hops grown in Japan from imported seed and comparison of results with the known composition of the European product gave forcible proof of the correctness of the supposition.

I.

COMPARATIVE COMPOSITION OF HOKKAIDO AND EUROPEAN HOPS.

| | Organic matter. | Ash. | Alcohol extract. | Water ex. from al.res. | $K_2O$ in ash. | $P_2O_5$ in ash. | Lupulin. Per cent. |
|---|---|---|---|---|---|---|---|
| English[1] Hops | 79.25 | 8.31 | 21.43 | | 20.45 | 17.01 | 12.75 |
| German[2] Hops | 79.45 | 7.54 | 26.45 | 13.02 | 34.61 | 16.80 | 12.40 |
| Hokkaido Hops '86 | 84.12 | 8.65 | 23.65 | | | | 9.13 |
| Hokkaido Hops '87 | 78.58 | 9.21 | 26.30 | 15.51 | 33.73 | 8.51 | 5.84 |

Unmistakable evidence is here furnished that a material deterioration has occurred in the hop since its introduction into the Hokkaido. This change is, moreover, chiefly a reduction in the quantity of lupulin; the local and the European product agreeing in all other constituents as nearly as different approved varieties grown under like conditions. The supposition, therefore, that a change in hop composition was the prime cause for deterioration of the beer produced seems established as a fact.

The analyses of the two successive crops of 1886 and '87 establish the further fact, that this diminished lupulin formation has not yet reached its minimum, but is still continuing to the extent of 28.36 per cent in a single year.

The cause for this marked and continuous deterioration in hop value through diminished lupulin formation is at first incomprehensible; especially as in physical appearance, and yield of fruit, the hop vines appear exceptionally thrifty and luxuriant. Moreover the condition of climate and soil appear superficially most nearly akin to those of the famous hop producing regions of Europe.

A careful study of the habits of the plant offers a clue to the satisfactory solution of the enigma. The essential properties of the hop exist exclusively in the lupulin formed at the base of the cones and around the seeds, and consist of three distinct compounds known as the volatile oil, hop-bitter and hop-resin. These complicated carbohydrates are almost exclusively formed during the ripening process of the fruit, the maximum content being found at the time of the full maturity of the seed. The ripening process occurs with great regularity during the months of August and September and like all vegetable carbohydrate formation results primarily through the specific action of sunlight. It necessarily follows that, other things being equal, lupulin formation is proportional to the amount of sunshine present during the time of formation; that is, during the months of August and September.

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[1] Average of all analyses of Way, Watts, Ure and Potter.

[2] Koenig, "Nahrungsmittle."

The average annual rainfall in Sapporo[1] for the five years 1882-86, inclusive, was only 37.67 in. During this period, however, the average fall for the months of August and September was 10.18 inches equivalent to 27 per cent of the entire annual rainfall; a proportion wholly exceptional and far in excess of that existing in any other hop-growing locality, the famous hop-producing regions of continental Europe being notably free from late summer and early autumn rains, the growing months of June and July being the chief rain-yielding seasons.

The cause of the diminished lupulin product of imported hops becomes therefore readily apparent and is rationally explained by this climatic peculiarity of the Hokkaido.

The dependence of lupulin formation upon atmospheric conditions being established, the question is naturally presented: can lupulin production be in any way rendered independent of these deleterious influences?

Climatic conditions are themselves beyond control, but the plant is equally dependent on the character of food supplied by its habitat, and this latter factor is largely subject to definite control. The results of my experiments to determine in how great a measure lupulin formation may be influenced by artificial food supplies, and in what way the deleterious influences of climatic conditions might be overcome have already been reported in detail,[2] together with observations on the demonstrated relations between organic plant constituents and mineral plant food.

The action of potassium compounds on the organic, especially carbohydrate, constituents of many plants has already been the subject of extended experiment and is well known. But the peculiar effects of these compounds on lupulin formation as developed by my experiments are of such a nature that I desire to record the facts as thus far developed. I select the results of two experiments, potassium sulphate being used in one case, and an equal amounts of potassium oxide in the form of the nitrate in the other. Quantities of materials used are not given, being immaterial, as affecting the specific action of each compound.

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[1] Capital of the Hokkaido.

[2] Report of the chemist to the Hokkaido cho for the year 1888.

### II.
### ANALYSES SHOWING THE DIRECT ACTION OF POTASH ON LUPULIN FORMATION.

| | Organic matter. | Ash. | Alcohol extract. | Water ex. from residue. | Lupulin. |
|---|---|---|---|---|---|
| Treated with $K_2SO_4$...... | 81.16 per ct. | 8.64 per ct. | 29.55 per ct. | 13.51 per ct. | 7.19 per ct. |
| Treated with $KNO_3$..... | 80.44 " | 9.19 " | 26.28 " | 12.75 " | 5.86 " |
| Hokkaido hop without special treatment.. | 78.58 " | 9.21 " | 26.30 " | 15.51 " | 6.19 " |

It is here apparent that excess of potash in the available supply of plant food exerts an influence on lupulin formation as marked and certain as does the excess of rain during the period of elaboration, but in a diametrically opposite direction; the presence of potash appears from these analyses to have very largely counteracted the deletrieous effects of excessive rainfall; and the average lupulin product of the two samples of hops grown in presence of excess of nutritive potash was 6.52 per cent as against 6.19 per cent produced by the average untreated Hokkaido hops.

This much for the conditions modifying lupulin formation.

Reference to this table of analyses, however, must show the existence of a factor heretofore strangely overlooked by analysts, viz., the relation between the ingredients soluble in alcohol and those extracted by water from the alcohol residue.

That the extractive ingredients of hops were successively soluble in ether, alcohol and water, is a fact long recognized by chemists as the basis of several analytical methods for determining the lupulin content and consequent value of the article. But the fact that the brewing value of hops must consist wholly of material soluble in either alcohol or water seems to have failed to receive attention commensurate with its practical importance; and the recognition of the existence of a fixed ratio between these two factors as an adequate means for fixing the lupulin content and consequent value of the hops seems to have escaped notice.

In table I. the relation between these two factors of alcoholic extract and water extract from the residue insoluble in alcohol, expressed in simple ratio is found to be represented thus:

RATIO OF ALCOHOL EXTRACT TO WATER EXTRACT.

I. 1:0.457
II. 1:0.484
III. 1:0.588
IV. 1:0.491

The fact is here graphically presented that the ratio between these two classes of extractive matter is, for good hops, fixed within narrow limits of variation; still further illustrated by ascertaining the ratio as demonstrated by all the available analyses in which these two factors appear.

Sixteen such analyses [1] give the following results:

Ratio of alcohol extract to water extract, as determined from the results of different analysts and for different varieties of hops:

III.

| | Alcoholic extract. | Water extract from residue. | Ratio. |
|---|---|---|---|
| Maximum | 25.50 per cent. | 16.66 per cent. | 1: 0.651 |
| Minimum | 18.00 " | 9.95 " | 1. 0.453 |
| Average of 16 analyses | 23.24 " | 12.46 " | 1: 0.536 |

In this table only the last ratio, that obtained as the average from 16 analyses, is of positive value as indicating the relation existing between these two factors as actually found in normal hops, The two other ratios, however, being obtained by comparison between maximum and minimum factors, indicate the limits of possibility in variation so far as all available analyses supply data for such criteria. The ratio 1: 0.536 therefore represents the average normal relation existing between the alcohol and the alcoholic-residue-water-extractive principles. While from this normal average the variations may extend upwards or downwards to the extremes 1:0.651 and 1:0.453.

This relationship being established it remains to demonstrate its significance as related to the lupulin content of hops, and its applicability to the determination of lupulin and consequent relative value of different hops.

Below are given facts demonstrated by definite analytical determination of the three factors, alcoholic extract, water extract from alcoholic residue, and actual lupulin content:

IV.

HOP ANALYSES SHOWING RELATION BETWEEN EXTRACTIVE PRINCIPLES AND LUPULIN CONTENT.

| No. | Alcohol extract. | Water ex. from residue insoluble in alcohol. | Ratio between the extracts. | Lupulin in dry matter. |
|---|---|---|---|---|
| I | 29.55 per cent. | 13.51 per cent. | 1; 0.457 | 7.19 per cent. |
| II | 26.28 " | 12.75 " | 1: 0.484 | 5.86 " |
| III | 25.67 " | 12.21 " | 1: 0.475 | 6.19 " |
| IV | 24.51 " | 13.17 " | 1: 0.537 | 6.71 " |
| V | 26.30 " | 15.51 " | 1: 0.589 | 5.54 " |
| VI[2] | 22.72 " | 13.82 " | 1: 0.608 | 4.09 " |
| Average... | 25.83 " | 13.49 " | 1: 0.522 | 5.93 " |

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[1] Sievert, Mosier, Soxhlet: König, Bd. II. *Chemmie der menschl. Nahrungsmittel.*
[2] Hokkaido wild hop.

These figures indicate the average results obtained from four distinct analyses of six different specimens of hops and may therefore be accepted as offering reliable facts at least concerning the specimens treated. Yet in every case the truth is apparent that the lupulin content is directly and invariable proportional to the ratio between alcohol and water extractive principles. *The greater the proportion of material soluble in alcohol, as compared to the residue soluble in water, the higher the percentage of lupulin present, and conversely.*

The average ratio in these analyses is seen to coincide most closely with the European results: 1: 0.522 as against 1: 0.536; a difference of but 0.015. Yet the average lupulin content of the Hokkaido hops is found to be but 5.93 per cent against 11.34 per cent in the European. Here, however, the utility of the ratio as a criterion for determining *relative value* is at once apparent and forcibly supplements the fact, of which every practical analyst is aware, namely, the difficulty, nay, almost impossibility, of determining hop value or lupulin content by actual physical separation; and at the same time the utter absence of any more satisfactory means of determination[1].

The difficulty of accuracy in actual lupulin separation, however, together with the limited number of analyses in which both the results of extraction and physical separation are recorded, render a definite statement of the relation between the two factors at present impossible. This much is however proved: *The greater the disproportion between the two extracts, the higher the lupulin content*—a fact demonstrated by all available analyses from every known source.

The average ratio of 22 analyses, European and Japanese, is 1: 0.529.

I submit that this factor offers far more reliable criteria, as a means of establishing *relative value*, than the general statements offered by such authorities as Watts, Way, Ure, Blythe, Post, Tomlinson, Musprat and König, varying from 7 to 20 per cent of the dry weight of the hop. Good hops should yield a ratio of 1: 0.529 between extremes. Above this to the maximum actual analytical results for cultivated hops 1: 0.453 the best analyzed specimen, and down to 1: 0.827, the poorest specimen yet recorded.

The actual percentage of lupulin indicated by a given ratio is not essential, may perhaps be impracticable and can at present be determined only under reservation. In this connection the Hokkaido product is not wholly normal and therefore is best excluded.

However, if 11.34 per cent. is accepted as the nominal average lupulin product, and the ratio 1: 0.536 as the average relationship between the two extractive principles, the actual quantity of lupulin corresponding to any ratio thus established is immediately obtainable. The following formula supplying the necessary data and yields the final result desired: $11.34 \div 0.536 \times \mu$. The first factor representing the average lupulin content; the second factor expressing the normal ratio between extractives and corresponding to the average percentage of lupulin. The third factor is supplied by the ratio as determined by extraction of the given specimen *representing the water extract in the ratio between extracts in the specimen examined.* The first factor divided by the second and the result multiplied by the last factor, must therefore give the *proportionate* lupulin content of any given hop as compared with the average of all known analyses.

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[1] Post. Technische-Chemische analyse Braunschweig, 1882, p. 816.

The method of lupulin estimation thus proposed, though falling short of an *absolute determination* is based on factors gravimetrically determined. And though subject to modification, as subsequent analyses increase the data at our disposal, the method must prove a most serviceable medium for use in a most important and frequent determination for the conduction of which no acceptable method has heretofore been proposed.

NOTE. The term "water extract" as used refers to the substance extracted by boiling water from the residue insoluble in alcohol.

Imperial agricultural college,
Sapporo, Japan, July, 1888.

# EDITORIAL.

THE association of agricultural colleges and experiment stations met at Knoxville, Tenn., Jan. 1–4. The meeting was unquestionably a very profitable one to all concerned, and the order of business was strictly adhered to. One feature, however, was noticeable, and that was, some of those who took the most active part in the proceedings were men not at all earnestly interested in agricultural research, known, if you please, as "literary fellers," while some of those whose counsels would certainly have been worth consideration, from their acquaintance with agricultural work, were too little heard from.

It is evident that the words "colleges and" have no place in the title of this association, for hardly a word of the discussion related to them, while everything bore upon the stations. We believe that all the purposes of the body would be solved, if it consisted simply of station directors and their assistants. That some of the present college presidents, from a moral standpoint, should remain in the back ground, was the opinion of many members present this year.

* * *

THE society for the promotion of agricultural science is the only organization in the United States, national in character, founded for the purpose of promoting agriculture through scientific investigation. Established in 1879, is has numbered among its members the leading investigators of the country, in lines of research bearing on agriculture.

Since the organization of the society, 54 persons have become members. In 1883 a rule was passed "that, in case a member of the society shall neither be present at any meeting for three consecutive years, nor present a paper during this time, his name shall be dropped from the list of membership."

In the table below, we present information which we believe will be of interest to the members of the society, and others. The figures in brackets show the year the persons against whose names they are placed, became members. The figures at the right of these, indicate what years members of the society have presented papers to it, while in cases where membership is dropped, it is so noted against the name.

Alvord (82)—83-85-86-87
Armsby (82)—85
Arnold (79)—81-82...............Died 88
Arthur (86)
Babcock (86)—87-88
Barry (79)...........................Out 85
Beal (79)—81-82-84-85-86-87-88
Bessey (80)—83-85-87
Brewer (80)—81.....................Out 88
Burrill (81)—82-85-87
Caldwell (79)—81-82-85-86-88
Collier (80)...........................Out 87
Comstock (80)—82.........................
Cook, A. J. (80)—82-86-87
" G. H. (81)—82
Dabney (82)..........................Out 87
Daniels (81)..........................Out 83
Dwinelle (81)—82..................Out 85
Farlow (80)—83-85-86-88
Fernald (80).........................Out 86
Frear (88)
Forbes (83)—86-88
Goessmann (80)—82..............Out 85
Gulley (81)—82-84
Halsted (80)—81-84-87-88
Henry (81)—83-88
Hilgard (80)—81-82-85-86-87-88
Jenkins (85)
Johnson (80).........................Out 86
Jordan (81)—82-84................Out 87
Kedzie, R. C. (80)—81-82-86-88
" R. F. (81)................Died 82
Knapp (83)...........................Out 86
Ladd (88)—88
Law (79)—82
Lazenby (83)—86-87-88
Ledoux (80).........................Out 85
Munson (85)—86-87
Myers (87)
Neale (87)
Riley (82)—85-87-88
Roberts (81)—88
Salmon (81)—82-86-87-88
Sanborn (81)—82-86-87
Saunders (85)
Scribner (86)—86-87-88
Shelton (81)—83-88
Stockbridge (80)...................Out 85
Sturtevant (79)—81-82-83-84-85-86-87-88
Thomas (80)—81-82-83.........Res. 86
Tracey, S. M. (81)
" W. W. (81)—82-85.....Out 88
Trelease (86)
Wiley (86)—87-88

Total members from first..................................54
Dropped 14 }
Died 2 } ..................................................17
Resigned 1 }
Total present membership..................................37

From the above, we see that 14 members have been dropped, according to the rule of 1883. If this rule means that a member need not present a paper if he will only be present to at least one of three consecutive meetings, the membership is all right, but if to retain that place members must present papers once in three years, then, according to the annual reports, there are members who should also be dropped. Certain it is, the mere fact that a member may happen in at a meeting ought not to retain him his membership, without further effort.

Of those persons already dropped from the list, while some men of eminence as investigators have fallen by the wayside, the majority are persons who do no active scientific work at the present time. It is unfortunate that the society should lose such men as Goessmann, Brewer, Jordan, Johnson, etc., but if they will not assist in maintaining such an organization, then those who will should take their places.

The proceedings of the society at the present time are the most valuable report as related to scientific agriculture, that we have. With a little more discrimination in receiving and publishing contributions, this value in future will be notably enhanced.

## RECENT LITERATURE.

REPORT OF THE PENNSYLVANIA STATE COLLEGE for the year 1887. Part II. Agricultural experiment station, pp. 226.

The fact is an interesting one that, while plat experiments more frequently give unexpected and enigmatical results than otherwise, the demand is that they shall be carried out. The practical farmer does not understand the fallacy of the plat test, so he calls for much of this work, while the experiment station man, if he has given the subject careful scrutiny, knows the weakness of the plat system, yet does not expose it before the farmer.

In this volume we find reports of plat tests with fertilizers, which yield results in no wise better than a multitude of others. We believe the work is carefully done, but after it is accomplished, even though it makes a report, what has been gained otherwise?

In fact, most of the ten conclusions concerning fertilizer use, on pages 34–36, show results "discordant," worthy of "little stress" or different from former tests. However, Dr. Frear in reflecting on the errors of experiment, takes a position similar to our own, when he says "more refined and costly methods must be employed." Yet practically speaking, the cost is not so great, year for year.

If our stations will do less plat work and give their energies to a greater degree on a smaller scale toward developing a more perfect plat system, a great point would be gained. Without question the most valuable comparative plat tests will extend through a term of years, and the longer the better.

A careful examination of this report, which is for a period prior to the income from the Hatch fund, indicates a considerable amount of work, to a large extent with field crops, with chemical analyses to draw deductions from.

The frequent tables are usually placed sidewise on the page, while some of them could be placed horizontally equally well, and be referred to with much more ease.

However, one hardly feels very much justified in critizing the *careful* work of men who find it necessary to devote a share of their time to the class-room. If they do this and experimental work, well, they deserve thanks rather than criticism.

## PUBLICATIONS RECEIVED.

CORNELL UNIVERSITY: College of agriculture. Bulletin of the agricultural experiment station, III. November, 1888, pp. 25–43, pl. I, figs. 5–15. 1. The insectary of Cornell university. 2. On preventing the ravages of wire worms. 3. On the destruction of the plum curculios by poison.

DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION. Bulletin No. 2. September, 1888, pp. 6, Newark, Delaware.

FOOD AND DRUGS IN THE DISTRICT OF COLUMBIA. Regulations concerning analyses of, under control of the commissioners of internal revenue. Nov. 20, 1888, pp. 31. Washington: Government, 1888.

FREAM, W. On the flora of water-meadows, with notes on the species. Extracted from the Linnean society's journal, xxiv. pp. 454–64. From the author.

FRUWIRTH, C. Der erste Futterbaucurs in Oesterreich, pp. 7. Extracted from *Wien. Landw. Zeit.*

INTERNAL REVENUE, Report of the commissioner of. For the fiscal year ended June 30, 1888, pp. ccxxiii. Washington: Government, 1888,

KANSAS STATE AGRICULTURAL COLLEGE EXPERIMENT STATION, Manhattan, Kansas. Bulletin No. 5, December, 1888, pp. 12. Some comparisons of varieties of sorghums. Preliminary report on sorghum blight.

KEW, Royal gardens. Bulletin of miscellaneous information. No. 25, January, 1889, pp. 28.

LOUISIANA STATE EXPERIMENT STATION, Bulletin No. 18 of the, pp. 137–162. Analyses of commercial fertilizers.

MICHIGAN AGRICULTURAL COLLEGE, First annual report of the department of botany and forestry of the experiment station of the. For the year ending June 30, 1888,pp. 25.

MICHIGAN, for the years 1887 and 1888, First report of the directors of the state forestry commission of, Lansing: Thorp and Godfrey; 1888, pp. 92, ill. numerous.

MISSISSIPPI AGRICULTURAL EXPERIMENT STATION. Bulletin No. 4, pp. 8. The marls of Mississippi. Nov. 7, 1888.

MISSOURI AGRICULTURAL COLLEGE EXPERIMENT STATION. Bulletin No. 4, pp. 24. A test of tillage implements.

NEW JERSEY AGRICULTURAL COLLEGE EXPERIMENT STATION. Bulletin L, Dec. 5, 1888, pp 21, figs. 5. Insects injurious to the cabbage and the best means of preventing their ravages.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION. Bulletin No. 60. October-November, 1888, pp. 137-52, pl. 3, IX. Lucerne, its value as a forage crop. X. Meteorological summary for September-October, 1888.

TENNESSEE, Bulletin of the agricultural experiment station of the university of, Vol. I. No. 3. October, 1888, pp. 29-52, plates ix. Weeds of the farm.

TENNESSEE, First annual report of the agricultural experiment station of the university of, for 1888, to the governor, Knoxville, 1889, pp. 24.

VERMONT STATE AGRICULTURAL EXPERIMENT STATION. Bulletin No 13, November, 1888. pp. 12. Methods of cutting and planting potatoes. Fertilizer analyses.

WEST VIRGINIA AGRICULTURAL EXPERIMENT STATION, Bulletin No. 1 of the. At Morgantown, W. Va., July, 1888, pp. 16. Organization and work of the station.

# ABSTRACTS.

## THE ALBUMINOUS BODIES OF MILK.

### I. METHODS OF DETERMINING ALBUMINOUS SUBSTANCES WITH PARTICULAR REGARD TO MILK.

(By JOHN SEBELIEN. Author's resumé in *Biedermann's Centralblatt*, 1888, xi, p. 755.)

As a result of special study of methods of precipitating albubuminous substances (casein and albumin) it was found that among solutions of metallic salts, basic acetate of lead acted very incompletely, but that copper sulfate used according to Ritthausen's method effected complete separation. Tannic acid and phosphor-wolframic acid in sulfuric acid solution are also complete precipitants, even when used in excess: "Albumose" and peptone are only partially separated by tannic acid, more completely so, however, by phosphor-wolframic acid. Total albumin is calculated from the nitrogen obtained by Kjeldahl method, from the complete precipitate obtained by one of the above reagents. Casein and albumin may be separated in milk by saturation with magnesium sulfate or sodium chloride. Casein is thus completely precipitated and either tannic or phosphor-wolframic acid added to the filtrate precipitates the albumin.

In an investigation as to whether albumose or peptones occur in normal milk, which might have a value in the determination of total albumin, it was found that peptones were never present in natural milk, colostrum, sour milk, buttermilk or whey. The single instance where it was noted was in a sample of "ropy" milk. A small quantity of non-albuminous, nitrogenous substance is always present, which on the average amounts to 0.04–0.05 per cent N in original weight (in colostrum 0.08%).

The albuminoids of colostrum were specially studied. According to former investigations, it was indicated that probably a large part of what is commonly designated as albumin was really globulin. This substance, which occurs in traces in normal milk, is completely precipitated along with the casein by magnesium sulfate, only partially so, however, by sodium chloride. By a study of these relations and by various methods described in the original paper, it was possible to effect an approximate separation of the two and to establish maximum and minimum limits for the amounts of globulin present. Following are the analytical results from five samples of colostral milk of the first and second milkings:

| I. Total nitrogen. | II. Total albuminoid nitrogen. | III. Nitrogen precipitated by MGSO$_4$. | IV. Nitrogen as casein (approximate.) | V. Nitrogen as globulin (approximate). | VI. Nitrogen as albumin. | VII. Non-albuminoid nitrogen. |
|---|---|---|---|---|---|---|
| 1.232 | 1.025[1] | 0.887 | —— | 0.100 | 0.138 | 0.207[3] |
| 2.506 | 2.269 | 2.020 | 0.560 | 0.248<br>1.460 | 0.250 | 0.237[3] |
| 2.566 | 2.461 | 2.147 | 0.534 | 1.604<br>1.613 | 0.314[2] | 0.086 |
| 2.222 | 2.086[1] | 1.903 | 0.718 | 0.300<br>1.185 | 0.183 | 0.076 |
| 1.100 | —— | 0.716 | 0.550 | 0.081<br>0.166 | —— | —— |

It appears from this that the albuminous substances of colostral milk undergo great variations. The casein is constantly in higher percentage than in normal milk; the albumin while somewhat abnormal does not reach the limits indicated in the literature. Globulin appears in all cases as an important constituent. The non-albumoid nitrogen seems also to be higher here than in normal milk.

### II. ORIGIN OF THE ALBUMINOUS BODIES OF MILK.

(By Prof. A. EMMERLING: *Biedermann's Centralblatt*, 1888, xii, p. 861.)

By an independent investigation into the modifications of animal albuminous bodies, the author arrived at results which in some respects agree closely with those of Sebelien noted in the preceding abstract.

The amount of globulin contained in colostral milk, particularly the first drawn, was surprisingly great—in one case eight per cent. The colostrum was diluted five fold and treated with sufficient acetic acid to precipitate the casein, filtered and the globulin precipitated from the neutralized filtrate by means of sodium chloride. The globulin was purified by solution and reprecipitation. Finally it was dried at 30° and preserved, in which form it was easily soluble in water to an opalescent fluid. Quantitative determinations were made as follows: Casein by precipitation with acetic acid, extraction of fat, drying and weighing. From the filtrate, globulin was precipitated by magnesium sulfate, resolution and coagulation by boiling, with addition of a little acetic acid, and weighing. In the slightly acidulated filtrate, albumin was finally precipitated by boiling.

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[1] Calculated from iii & vi.
[2] Calculated from ii & iii.
[3] Calculated from i & ii.

Sebelien's statement that by coagulation of albuminous fluids, a portion remains in solution, is corroborated by the author. Possibly the so-called "lacto protein" is only this soluble albumin-like residue. Following are the analytical results of an examination of colostrum from the same cow, from immediately after calving, on :

| | Dry matter. | Casein. | Globulin. | Albumin. |
|---|---|---|---|---|
| 1. Morning | 23.86 | 4.705 | 8.320 | 0.580 |
| 2. Evening | 12.80 | 2.865 | 0.930 | 0.440 |
| 3. Morning | 14.64 | 2.840 | 0.695 | 0.510 |
| 4. Evening | 12.73 | 2.965 | 0.275 | 0.475 |
| 5. Morning | 12.69 | 3.010 | 0.180 | 0.375 |
| 6. Evening | 12.94 | 3.255 | 0.180 | 0.380 |
| 7. Morning | 13.09 | 3.145 | 0.150 | 0.210 |
| 9. Morning | 15.09 | 3.160 | 0.105 | 0.370 |
| 11. Morning | 12.88 | 2.290 | 0.040 | 0.200 |

The error caused by incomplete coagulation of the globulin and albumin, is not taken into account in these data. A marked feature is the remarkably rapid decrease of the globulin, even from morning to evening of the first day, corresponding also to the observations of Sebelien. The bearing of this upon the question of milk formation is important.

Other results of the investigation were :

The statement of Kemmerich that by long standing of milk casein was formed at the expense of albumin, was not substantiated. A preparation of globulin contained 15.72 per cent. N. Hammarsten obtained 15.85 per cent. N. for the paraglobulin of blood. The temperature of coagulation for globulin corresponded also to that of paraglobulin under similar conditions. This indicates identity of the two. The author however is unwilling to admit this at present, since the rotatory power of globulin was far greater (about three fold) than that observed for paraglobulin.

W. E. S.

## THE HYBRIDIZATION OF CINCHONAS.

(By DAVID HOOPER : *Tropical agriculturist*, viii, 6.)

There are two well-defined species of cinchona on the plantations of the Madras government, *C. succirubra*, Pav., yielding a red bark, and *C. officinalis*, Hook., yielding the crown bark of commerce.

Between these two barks many hybrids are recognized, and have been cultivated and exported largely. Hybrids assume the quick growing character of the *succirubra*, yet they contain a greater proportion of quinine than that species. They do not as a rule contain the percentage of quinine usual to *officinalis*, but the large quantity of bark yielded by the tree, and the high total alkaloids, make them equal in value to the best crown barks.

It is first necessary to discuss the alkaloid composition of the two species between which hybridization has taken place.

*Cinchona succirubra* has a peculiar centesimal arrangement of alkaloids in its bark, varying between certain limits. In 50 selected barks of this species, the quinine ranges from 17 to 27 per cent., cinchonidine, 26 to 51 per cent., cinchonine from 17 to 47 per cent. and *amorphous* alkaloids from four to 23 per cent.; beside these the alkaloid quinidine occurs in traces in red barks, up to 0.5 per cent.

*Cinchona officinalis* has quite a different arrangement of alkaloids in its bark. In a table of 50 analyses, on selected barks, nearly all from the Nilgiris, quinine ranges from 48 to 62 per cent., cinchonidine, 18 to 33 per cent., quinidine, 0 to 6 per cent., cinchonine from two to 16 per cent. and amorphous alkaloids from four to 13 per cent.

The following table gives the average figures from each table of analyses, above referred to:

TYPE OF BARK.

| | Succirubra. | Officinalis. |
|---|---|---|
| Quinine | 1.40 | 2.93 |
| Cinchonidine | 2.25 | 1.40 |
| Quinidine | | .08 |
| Cinchonine | 1.92 | .42 |
| Amorphous alkaloids | .68 | .42 |
| Total | 6.25 | 5.25 |

There are two kinds of hybrids grown on the estates at Naduvatam, named *magnifolia* and *pubescens*, the former resembling externally *officinalis*, the latter, *succirubra*. Twenty-five analyses were made on the natural bark of individual trees from seven to 16 years of age. Figures for cinchonidine more or less increase with the decrease of quinine. Quinidine as a rule is found in barks where quinine predominates, and in that called *pubescens*. The less valuable alkaloids deteriorate in the hybrids. The cinchonine is the same as in *officinalis*, while the amorphous alkaloids are much lower than in the *succirubra*.

Several plats at Naduvatam are devoted to the culture of hybrids. A few analyses from selected trees five years of age are given below:

| Kind of tree. | Quinine. | Cinchonidine. | Quinidine. | Cinchonine. | Amor. alk. | Total. |
|---|---|---|---|---|---|---|
| 1. Hybrid | 3.32 | 2.90 | —— | .41 | .49 | 7.21 |
| 1a. " | 2.58 | 2.91 | —— | .43 | .63 | 6.55 |
| 2. " | .87 | .98 | .13 | 2.96 | .70 | 5.64 |
| 2a. " | .90 | 2.75 | —— | 1.05 | .40 | 5.10 |
| 3. Officinalis | 2.85 | 1.11 | .11 | .46 | .35 | 4.88 |
| 4. Succirubra | .85 | 1.24 | .15 | 2.79 | .57 | 5.60 |
| 5. Officinalis | 3.10 | 1.88 | .09 | 1.17 | .56 | 6.80 |
| 6. Succirubra | 1.35 | 2.67 | —— | 1.36 | .96 | 6.34 |

No. 1. Hight nine feet; girth six inches. Leaves broadly ovate, crumpled, glabrous, dark green, glossy above, strongly pubescent beneath, six by four inches, base rounded or slightly produced in the leaf-stalk.

No. 2. Hight 10 feet; girth six and one-half inches. Leaves eight by four and one-half inches, ovate, flat, glabrous above and beneath, as also the young shoots, dark green, shining base rounded or slightly produced.

No. 3. Approaching *officinalis* type. Hight nine feet; girth eight inches. Leaves five by three inches very broadly ovate, dark green, shining above, glabrous on both surfaces, base rounded, scorbiculæ on upper surface prominent.

No. 4. Approaching the *succirubra* type. Hight eight feet; girth seven inches. Leaves broadly ovate, shining above, slightly puberulous beneath, dark green, crumpled, produced at the base.

No. 5. Approaching *officinalis* type. Hight nine feet; girth five and one-half inches. Leaves four by one and one-half inches, lanceolate, narrow, perfectly glabrous, dark green, glossy, folded inwards upon the upper surface, leaf stalk reddish.

No. 6. Approaching *succirubra*. Hight 10 feet; girth eight inches. Leaves and young shoots pubescent. Leaves ten by eight inches, light green, variable in size, crumpled, base scarcely produced.

In the plat where these barks were collected it was noticed that the trees of the parent forms flowered and seeded first, but that the hybrids were more vigorous in their appearence and had more foliage than the species.

## BURSATTE.

(By J. R. ANDERSON: *Jour. comp. med. and surg.*, x, pp. 71–77.)

The writer knows of no record of this disease excepting in India. The disease is characterized by the formation of hard elevated patches, single or double, within the skin and cellular tissue. The chief symptoms are heat and tenderness upon pressure, and they show a tendency to enlarge and ulcerate, with a proneness to recurrence, and general decline of health. The ulcers are of an extremely vegetative luxuriance and an exuberant vitality; highly vascular, and becoming very malignant in their latter stages. The first appearance of the disease is marked by tumefied patches, soft at first but rapidly becoming indurated, elevated and circumscribed, the line being well marked between the morbid and normal tissue; and the skin remaining intact, presenting at this period no sign of disease beyond hyperæsthesia. In one to six days fissures appear upon these enlargements with a yellowish-brown serous exudation issuing from them, followed rapidly by ulceration, which completely divests the entire surface of the enlargement of its covering, but not attacking the integument beyond the defined line.

There are three forms of ulcers described, all much alike in early development, called papillated, circular medium and phagedænic, the second being an intermediate form, and the latter an eating or sloughing form, very destructive. The latter kind is at present prevalent in Kansas and northern Alabama, and is the only one which proves fatal, though seldom.

The following is a description of the papillated form: On completion of the removal of the integument by ulcerative process, we have presented a vigorous circular ulcer, the diameter of which corresponds to that of the original enlargement; not well defined at its border which is ragged; sloping from its circumference on all sides downward and inward, forming about its center a pit-like depression. The surface is covered with innumerable papillæ which bleed easily, and the entire ulcer has for its base a decided elevated induration which is movable upon manipulation, seeming not to involve any tissue beyond the cellular.

After the maturity of an ulcer, an effort at repair follows, in which cicatrization is completed, but only remains intact for a period varying in duration from a few weeks to months, when the same process of destruction is again established, and the ulcer reopens, but never closes the second time without medical and surgical aid.

One peculiar feature is the metastatic tendency of bursatte. Should two or more tumors appear at the same time on different parts of an animal, upon one or more openings simultaneously, the remaining ones disappear without doing further damage. If the tumefactions appear on the limbs they are below the knees and hocks in every case, while those occurring elsewhere are about the face, neck, angles of the mouth, and never posterior to the anterior portion of the dorsal region.

The disease is non-inoculable to abraded tissue, and cannot be transmitted through the atmosphere. Animals feeding from the same manger and water, will not be affected.

The animals most subject to the malady are hard worked, poorly fed, coarsely bred horses and mules, living in bad hygienic condition.

## RESEARCHES UPON DRAINAGE.

(By M. BERTHELOT: *Comptes rendus*, cv, p. 690.)

A soil deprived of vegetation, procured from a place where it was not subject to subterranean drainage, was exposed to rain; it received with the water atmospheric nitrogen in the following combinations: ammonia, nitric acid and even organic nitrogen; it lost, in the form of nitrates, a certain quantity of nitrogen, carried away by the drainage water.

The author endeavors to determine the difference in the two figures of gain and loss, and learns that the nitrogen lost by drainage water is nearly ten times as much as that brought in the rain water.

A sod was taken from a meadow, dried in open air under a shed, and from it all stones and vegetable debris was sifted. Then 51 kilograms of soil dried to 110°, with 5 kilograms of water added, were placed in a large polished, stone ware receptacle, pierced on the under side with holes to allow the escape of the drainage water, which was secured and analyzed immediately, parallel with the rainwater added to the soil.

The soil occupied a depth of about 50 centimeters, and the upper surface covered 1520 square centimeters. At the first, it contained 0.380 gr. nitric acid, while at the end of the experiment the proportion of water raised it to 8.8 kilo, and the amount of nitric acid in the soil was 0.853 gr. The experiment began May 24 and terminated Nov. 20, 1886.

The soil had received 51.7 liters of water, and this contained:

| | Gr. | Gr. |
|---|---|---|
| Ammoniacal nitrogen | 0.048 | 0.061. |
| Nitric acid | 0.013 | |

The organic nitrogen in the rain-water raises these figures to 0.074 grams.

The ammonia gas carried by the atmosphere during the same time and at the same point of the meadow, upon the surface equaled in dilute sulfuric acid, 0.048 gr. Adding these two preceding sets of figures together, the total of 0.122 grams is secured, hence the author thinks we give an exaggerated value to the atmospheric nitrogen.

During the period of experiment 14.8 liters of water were gathered, hence nearly two-thirds of the rain-water had evaporated, 3.8 kilo having been retained by the soil. The drainage water contained 0.674 gr. of nitric acid.

Although the losses due to drainage water are greater than the gains which the soil made in atmospherical ammonia, nitric acid and ammonia from rain-water, the 51 kilos of soil in the pot had secured 12.85 gr. of nitrogen, a gain which the author thinks cannot be attributed to atmospherical nitrogen. The author conducted many other experiments of the same sort, always with a like result.

However, in 1887, an experiment was conducted, giving quite different results. A pot was used the surface of which embraced 1550 sq. cm. It contained 55 kilo. of vegetable soil representing 45 kilo. of dry soil. The rain guage placed near by had a surface of 706 sq. cm. The results below relate to a surface of a square meter. All the analyses took place within 48 hours after the rain.

| Date. | RAIN WATER. | | | DRAINAGE WATER. | |
|---|---|---|---|---|---|
| | Quantity received. | Ammoniacal nitrogen. | Nitric acid. | Quantity received. | Nitric acid. |
| | Lit. | Gr. | Gr. | Lit. | Gr. |
| June 3 | 31.87 | 0.0340 | 0.0070 | 0.36 | 0.220 |
| " 26 | 21.96 | 0.0050 | 0.0076 | 3.61 | 0.303 |
| July 22 | 49.58 | 0.0298 | 0.0098 | 12.91 | 0.840 |
| " 31 | 33.29 | 0.0133 | 0.0089 | 12.91 | 0.970 |
| Aug. 19 | 47.96 | 0.0326 | 0.0070 | 26.77 | 2.018 |
| Sept. 15 | 27.48 | 0.0098 | 0.0063 | 6.45 | 0.418 |
| Oct. 7 | 20.54 | 0.0186 | 0.0083 | 11.10 | 0.462 |
| | 232.68 | 0.1431 | 0.0554 | 83.11 | 5.240 |

Total nitrogen..........................................0.1985

A liter of rain water contained on the average :

| | Mg. | Mg. |
|---|---|---|
| Ammoniacal nitrogen | 0.62 | 0.86. |
| Nitric acid | 0 24 | |
| Organic nitrogen | 0.24 | |
| Total | 1.10 | |

*Ab.: Annales agromomique, xiv, pp. 283-85.*

## THE HESSIAN FLY.

(By K. LINDEMANN : *Naturw. Rundschau*, 1880, p. 206-207.)

The three generations of the Cecidomyia in central Russia, show an interesting dependence upon the growth relations of the cereals. Since the larvæ subsist only on the juices of certain cultivated cereals neither wild grasses nor their natural hosts after they have attained a certain degree of ripeness, can sustain their development. Their life of 28 days requires a stem which shall remain green and juicy for the entire period.

The spring generation find the green winter and summer grains in which to deposit their eggs, and the offspring are well nourished up to the time of flight which occurs chiefly in July. Larvæ from the eggs of the summer generation, must find nourishment until the middle of August, but in central Russia the winter wheat is ripe and dry before this time, hence only the summer wheat, or the secondary growth from the harvested winter wheat can serve them. The fall generation finds the young growth of the new winter wheat fields adapted to its use. In order therefore that the three generations may be regularly developed, it is necessary that the stems of the winter wheat should not become dry before the end of June, that summer grain be grown in the region, and finally that the season be warm in September and October in order that the fall generation may pass beyond the pupa stage. It is noted that where these conditions are fulfilled during a series of years, an injurious increase of the fly follows. Where no summer grains are cultivated (parts of southern Russia), the offspring of the spring generation are mostly destroyed. The strong increase of the fly in central Russia is undoubtedly due to the early coming of the winter grain, enabling the fall generation to lay its eggs on young plants.

As preventative methods, are suggested; to plow under stubble of summer grains immediately after the harvest; the sowing of small areas of grains in the neighborhood of infected fields about the end of June on which the July flight will lay its eggs and the field can then be plowed; later sowing of winter grain, and introduction of varieties with stronger stems.

*Ab: Biedermann's centralblatt, 1888, p. 857.*

## PHOSPHORUS AND PHOSPHORIC ACID IN PLANTS.

(By **BERTHOLOT** and **ANDRÉ**: *Comptes rendus*, 1888, pp. 711-16.)

The authors give the results of some experiments with *Amaranthus caudatus* and *A. pyramidalis*, protected from rain but freely exposed to the air, which show that the plant absorbs both phosphorus and potassium from the soil in the early stages of its growth, though the amount of both, and especially of phosphorus, increases less rapidly than the weight of the plant. When flowering begins, the absorption of phosphorus practically ceases, but the absorption of potassium continues so long as the plant grows, and the increase in the quantity of this element during flowering is very considerable. The increase in the quantity of nitrogen is almost proportional to the increase in the weight of the plant up to the beginning of inflorescence, although somewhat smaller in the early stages of growth. When the plant flowers, the total quantity of nitrogen increases but little, and therefore the proportion of this element decreases. In a soil containing about eight grams of potassium acetate per kilo., the plant grew with some difficulty, but those which survived became much larger. They contained nearly twice as much potassium as under normal conditions, but the increase in the amount of phosphorus followed the ordinary law.

From the results detailed in this paper, it follows that manures containing phosphorus and nitrogen are of no value after the plant has begun to flower, but manures containing potassium may be useful throughout the whole period of growth.

*Ab.: Jour. roy. micr. soc., Oct., 1888, p. 760.*

## PERONOSPORA OF THE ROSE.

(By **G. CUBONI**: *Le Stazioni Sperimentali Agrarie Italianae*, Vol. xiv, 1888, p. 295-308.)

The author found that the conidia always had a spherical or slightly elliptical form. Sorauer's statement that the conidia produced only germ-tubes and no zoöspores was corroborated. Numerous ospores were found in buds which had been destroyed by the disease; these are globular, strongly refractory, and thick walled, with a diameter of 14–18 $\mu$. Their germination has not been observed.

The Peronospora has undoubtedly been introduced from America, probably by means of mycelium on grafts.

Sprinkling the rosestock with a one per cent. solution of copper sulphate is recommended; the plant must however be excluded from the sun's rays. Warmth and moisture are favorable to the development of the peronospora, but it is found in the open air only rarely. As an experiment, the disease was brought to a standstill on a single plant by placing it in the open air.

According to P. Freda (same journal as above, p. 309) the most effective mixtures for combatting peronospora are, four kilos of copper sulphate and four kilos of caustic lime in 130 liters of water, or 250 gr. copper sulphate and 250 c.c. of concentrated ammonia in 100 liters of water.

*Ab.: Bied. Centr., 1888, p. 851.*

## THE FLORA OF WATER MEADOWS.

(By W. **FREAM**: *Linn. soc. jour.*, December, '88, pp. 454–64.)

The author has made a special study of the flora of water meadows in the west of England. Eighty-five species of flowering plants were found, embracing 26 grasses, seven leguminoseæ, and 52 miscellaneous species. Compared with the flora on grass land at Rothamsted, there are 42 others in the meadow, of which 10 are gramineæ, or *Phaloris arundinaceæ*, *Alopecurus geniculatus*, *Agrostis alba*, *Phragmites communis*, *Glyceria aquatica* and *fluitans*, *Festuca duriuscula*, *elatior* and *loliacea*, and *Bromus racemosus*.

Of 127 species found on water meadows and dry meadows, half the number of the former do not occur on the latter, and vice versa.

Three grasses common to Rothamsted—*Avena pubescens*, *Dactylis glomerata* and *Festuca ovina*—do not occur upon the water meadows, but are common on the dry grass lands bordering the meadows. It is considered strange that Dactylis does not grow on the water meadows, as in America it naturally thrives in moist places.

Only two of the water meadow grasses are annuals, viz.: *Bromus mollis* and *racemosus*. The most abundant grass is *Holcus lanatus*.

## FEEDING OF CALVES AND PIGS.

(By N. J. FJORD: *Bied. Centr.*, 1888, pp. 590-601.)

Some experiments with pigs on the relative feeding values of corn, skim-milk and whey, and on other points, led to the following conclusions:—

1. The opinion that pigs make better use of their food when it is largely diluted with water, was not confirmed; the difference in increase obtained being either unimportant or to the disadvantage of dilution.
2. Although confining pigs produced more increase than allowing them to run in the sty-yard, yet the author thinks it may cause disease.
3. Twelve parts by weight of whey, six parts of skim milk, one part of bruised barley and one part of bruised rye, are of approximately equal feeding value.

*Ab.: Jour. chem. soc., December, 1888, p. 1319.*

## PARASITIC FUNGUS OF THE PINEAPPLE.

(By J. DE SEYNES: *Soc. et. mycol. de France*, 1888, pp. 26-30.)

In a recent work on the formation of ascospores, the author described a Hyphomycete belonging to the genus Sporoschisma, which he calls *S. paradoxum*. In this paper he adds more particulars about the same species. This fungus vegetates in the pulp of the fruit of the pineapple. The mycelium is composed of filaments which intertwine with the elements of the parenchyma of the host; these filaments are colorless, and but little branched. The sporophore appears first as a small spherical eminence, which becomes divided off by a septum from the mycelial cell. The sporophores bear at their summits the spores or conidia, which are unilocular and cylindrical.

*Ab.: Jour. roy. micr. soc., 1888, pp. 780-1.*

## ABSORPTION OF NITROGEN BY LEGUMINOSÆ.

(By E. BREAL: *Compt. rend.*, cvii, pp. 397-399.)

In several species of Leguminosæ, the total nitrogen in the plant is about twice as great as that originally present in the seeds. If, however, the roots are covered with tubercular nodosities, the amount of nitrogen is much greater. In one case with lucern, it was 25 times as great as in the seed. These tubercles can be transferred from one plant to another by inoculation. They contain a whitish liquid full of microscopic, highly refractive rounded granules and moving filaments which resemble bacteria.

*Ab.: Jour. chem. soc., Dec. 1888, p. 1330.*

## THE ABSORPTION OF NITROGEN BY PLANTS.

(BY HELLRIEGEL and WILFARTH: *Bied. Centr.*, 1888, p. 228–30.)

The experiments were conducted in boxes, and oats, buckwheat, peas, etc., planted. It was found that those of the Papilionaceæ order were able to grow and flourish long after all the nitrogen in the soil had been absorbed by them, while the oats and others only grew as long as there was any of the nitrogen left that had been originally contained in the seed and soil.

*Ab.: Jour. roy. micr. soc., 1888, p. 770.*

## AGRICULTURAL SCIENCE NEWS.

In the December, 1888, *American naturalist.* Prof. C. E. Bessey records "a few notable weeds of the Nebraska plains."

The first report of the directors of the state forestry commission of Michigan is of interest. It seems mainly the work of Prof. Beal, and is rather practical in character, and copiously illustrated. It contains a list of the trees and shrubs of Michigan.

The biographical directory of agricultural scientists is now in print, and will be on sale in a few days. It contains biographical information of 223 persons engaged in scientific work such as pertains to agriculture.

The United States department of agriculture is to issue a quarterly journal of mycology, with Mr. B. T. Galloway, chief of the section of vegetable pathology, as editor. It supplants Kellerman's *Journal of mycology*, and is free.

The minister of agriculture, of Victoria, makes the announcement that the government will probably select some land, to establish thereon an institution whose sole work shall be viticulture. It will be under the auspices of the central board of viticulture.

Mr. James Nuttall, a well known Leicestershire dairy farmer, has been appointed lecturer on dairying at the Royal agricultural college, Cirencester, England, in place of James Long, resigned. In making this appointment, it is stipulated that he shall not be designated "professor."

Prof. F. L. Scribner, botanist to the university of Tennessee station, and T. V. Munson of Dennison, Texas, have been favored by the French government with the order of merit of the legion of honor of France for investigations on the grape. This is a distinction sparingly conferred upon Americans.

The January bulletin of miscellaneous information of the Royal gardens, Kew, discusses the following topics: Coca. Beetles destructive to rice crops in Burma. Fibre from Lagos. Yam bean. Schweinfurth's method for preserving plants. A starch-yielding Bromeliad. The fruits of Mysore. The first two subjects contain matter of considerable interest.

The northern limits of silk-worm culture, are being gradually extended, according to *Nature* (xxixx, 9). Experiments made last summer at Astrakhan showed that it could easily be carried on at the mouth of the Volga. Experiments with trees planted 35 years ago, have proved very satisfactory.

A pamphlet of 31 pages from the United States internal revenue office, gives the regulations concerning analysis of foods and drugs in the District of Columbia, under control of the commissioner of internal revenue. An appendix contains a useful bibliography and literature of food and drugs and their adulterations, giving periodicals, official reports and general monograph volumes.

F. Sestina, in *Gazetta* (xviii, pp. 44–54), states that phosphoric acid and not the potassium salts are wanting in the excrements of the ox and horse; while the nitrogen exceeds the five per cent. usually regarded as the theoretical amounts necessary for a good manure. He draws these conclusions from a study of the analysis of a large number of manures.

The Lords of the committee of council on agriculture, have granted to the university college of North Wales, the sum of £200 in aid of the work of agricultural education, in which the college is engaged. Dairy schools are to be established in centers of counties, and will be visited from time to time by a lecturer and practical instructor in dairy work, etc., from the college at Bangor.

Through Herr C. Fruwirth, of Vienna, Austria, we learn that a course of lectures is given on the culture of forage crops in different parts of the country, the same lecturers traveling from place to place. The institution is both practical and theoretical, held much on the plan of the American farmer's institute. Field crops are visited in the vicinity, and practical object lessons given, while the theory is taught in the public hall. But one course has thus far been held, in the months of April and May, there being 18 in the first class and 10 in the second.

The report of the United States commissioner of internal revenue for the fiscal year ended June 30, 1888, contains interesting analytical and experimental work on methylated spirits, oleomargarine and food and drugs, by Edgar Richards, microscopist to the office of internal revenue. To this are also appended foreign laws, decrees, and regulations concerning the repression of adulterations practiced on articles of food and of drink. Exceedingly interesting figures are presented concerning oleomargarine production, and chemical tests on the same.

According to the *North British agriculturist* (Dec. 26, '88), a number of experiments in inoculation have been arranged by the Saxony agricultural society in order to obtain its effects upon pleuro pneumonia more minutely. Sixteen heifers from different parts of the country, totally free from pleuropneumonia, have been inoculated in three different parts of the body, the wounds being treated antiseptically, and the animals have now been sent to a farm where pleuro is reigning extensively, being mixed with the diseased cattle. The experiments are being conducted by Prof. Dr. Schutz.

Before the Royal horticultural society of England, on Dec. 11, '88, Prof. Church rendered an analysis of the tubers of the new vegetable, *Stachys tuberifera*, confining the results of Dr. Planta in *Landw. Versuch-Stationen* (5–6, 1888). They contain 78 per cent. water, 1.5 per cent. albuminoids, 1.7 per cent. non-albuminoids or amides, 16.6 per cent. sugars, .7 per cent. fibre, .1 per cent. ash, .2 per cent. fat and only a trace of starch. Comparing this analysis with potatoes, it appears that the water is in larger quantity, it being 75 per cent. in them; the flesh-forming albuminoids are rather more than in potatoes, while the sugars replace the starch, of which there is some 15 per cent. in the average analysis of the potato.—*Gardener's chronicle*, Dec. 15, '88.

A writer in *Garden and forest* (ii, 47) gives some information concerning the national school of horticulture at Versailles, France. It was established in 1874, and is a free school. The entering student must be between 17 and 27 years of age, and pass an easy examination in reading, writing, spelling and arithmetic. The regular course is three years. The work of the school is divided into 11 departments: First, fruit tree cultivation. Second, ornamental and forest tree cultivtion. Third, vegetable culture. Fourth, flower culture. Fifth, elementary and descriptive botany. Sixth, landscape gardening. Seventh, elements of physics, meteorology, chemistry, geology and mineralogy as applied to horticulture. Eighth, elements of zoölogy and entomology as applied to horticulture and arboriculture. Ninth, geometry and arithemetic necessary for gardening purposes. Tenth, linear design and sketching of plants and insects. Eleventh, French language and book keeping. Instruction is given through lectures and recitations, while manual labor is required, the time being divided between theory and practice. Good permanent museum collections are being formed such as bear upon horticulture.

## EXPERIMENT STATION ITEMS.

The fourth bulletin of the Mississippi station contains compiled matter relating to the marls of the state, and also analyses by Dr. B. von Herff of the station staff, and others from Hilgard's report.

"Analyses of commercial fertilizers" is the title of bulletin 18 of the Louisiana station. The fertilizer law is first given, then descriptive notes of the principal commercial manures, and finally analyses.

The second bulletin from the Delaware station is by M. H. Beckwith, on horticulture and entomology. Less than three pages, telling what the station will try and do in the subjects indicated.

Dr. H. E. Stockbridge, for three years past professor of chemistry in the Imperial agricultural college, Sapporo, Japan, has accepted the position of director of the agricultural experiment station of Purdue university, Ind.

The third bulletin of the Tennessee station is a preliminary report on the weeds of the farm. Nine illustrations of the more common ones are given. The information practically embodies no new research, and is merely descriptive of the more common weeds collected in the vicinity of Knoxville.

Dr. B. D. Halsted, for several years professor of botany in the Iowa agricultural college, has been elected professor of botany to Rutgers college, New Jersey, and horticulturist to the New Jersey agricultural experiment station.

The first annual report of the Tennessee station briefly explains the general nature of the work for the year 1888, or to use the language of the director to the governor, is "an official statement or account of our stewardship over the funds given us." Each division of station work makes a general report of the work attempted or in progress.

A test of varieties of sorghum and report on sorghum blight, occupy the 12 pages of the fifth bulletin of the Kansas station. Late orange, new orange and South Carolina early orange furnish noticeably large percentages of sugars. Prof. Kellerman notes the occurrence of sorghum blight—*Bacillus Sorghii*—describing it briefly.

The 13th bulletin of the Vermont station contains an interesting table concerning methods of cutting and planting potatoes; it also gives fertilizer analyses. It would have had a much greater convenience to general readers, if some conclusions concerning the results had followed the table. The make up of the bulletin of this station has materially improved from the first, but would it not be a good plan to adopt some system in numbering pages? These pages are not numbered.

The first annual report of the department of botany and forestry of the Michigan station pertains entirely to the Jack-pine plains of Michigan. Experiments with grasses and forest trees are now in progress in the pine regions of Michigan. This report gives the nature of these and other data concerning the character of the Jack-pine country, with a list of the flora.

# AGRICULTURAL SCIENCE.

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## EDITORIAL.

The fund of $15,000 available to experiment stations will be likely to cause some stations to buy lavishly of books and periodicals for the library. An abundance should not beget of us wastefulness or extravagance. Some stations, as we know, order direct of high-priced agents, without looking further. If our readers will go to a little trouble, they can easily learn of reliable book dealers who will gladly supply many periodicals at rates decidedly below publishers' prices. There is a striking difference in comparing the prices of our American news agents. We know of certain firms in Boston and New York who receive large patronage from experiment stations, yet their prices are much higher than others of New York, Chicago and elsewhere. Yet there is no difference in the reliability of the persons concerned. We advise our readers to look carefully in this matter if they wish to buy economically. In buying books, if one orders indiscriminately of one dealer he will be almost certain to pay roundly for his confidence. We speak advisedly, from experience, having purchased books from French, German and English houses, and at home. There are certainly many dollars to be saved in book-buying according to whom we purchase of.—*Agricultural Science* for December.

We recognize the truth of the statements made above. It is also true that institutions or persons ordering rural books will consult their own interests by dealing with a house like the Orange Judd Co., which makes a specialty of this business. We do not care particularly to handle subscriptions for periodicals, although we will do this to accommodate our customers when such subscriptions are in connection with the AMERICAN AGRICULTURIST.

The Orange Judd Co. is the leading agricultural book-publishing house in the world. We make a specialty of supplying books on agricultural and all kindred subjects and sciences for experiment stations, agricultural colleges, and for all institutions and individuals that may desire the same. We could not afford to oblige our patrons to "pay roundly" for their confidence in us, even if we were so disposed. The bulk of this business is now done direct through the Orange Judd Co., and should we charge our patrons, whether said institutions or individuals, unfair prices, they would very soon find it out, and we would lose their patronage.

We have been here for nearly 50 years, and propose to continue in the future as in the past the headquarters for the publication and furnishing of agricultural books. Since we make a specialty of this business, we can supply colleges, stations, societies and farmers generally with any book they want, promptly and as economically as they can be obtained elsewhere. We will also furnish any book published on other subjects. We gladly give the national experiment stations and agricultural colleges the benefit of our experience.

It is the intention of the new management of the Orange Judd Co. to continue the publication of our present strong list of standard and valuable works and also to bring out new books of real merit and value, as fast as the demand for them will warrant.

Writers engaged in preparing new works, or who have such in prospect, will do well to consult us. We may possibly be able to give intending authors points that will be of value and assistance to them, for we are in a position to do better by them than any other publishing house in the world. We shall publish only such books as are of intrinsic merit and that therefore will have a constant sale, so that their publication will be renumerative to the author as well as to the publishers.

We shall esteem it a favor if all the readers of AGRICULTURAL SCIENCE, the presidents of agricultural colleges, the directors of experiment stations, and professors and workers in all lines of the science and art of agriculture, will feel a direct interest in the Orange Judd Co., and confer with us freely on any matter of mutual interest, especially in the way of supplying books.

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Publishers American Agriculturist, and Publishers and Importers of all works pertaining to Rural Life.

The Georgia legislature, at its recent session passed an act establishing an agricultural experiment station. This station is to have the use of the Hatch funds. The board of directors is composed of the commissioner of agriculture, the chancellor of the state university, the state chemist, and a practical farmer from each of the ten congressional districts. This act destroys the station at the state university at Athens.

The 50th bulletin of the New Jersey station discusses "insects injurious to the cabbage and the best means of preventing their ravages." The insects referred to are the white cabbage butterfly, (*Pieris rapæ*. Linn.); cabbage plusia (*Plusia brassicæ*, Riley); cut worms; cabbage plant louse (*Aphis brassicæ*, Linn.); cabbage root fly (*Anthomyia brassicæ*, Bouché) and club root (*Plassmodiophora brassicæ*, Wor.) This bulletin is clearly written, in a serviceable manner, but embraces but little original work, being generally compilation.

A bill has been introduced into the United States house of representatives, by Mr. Funston, authorizing the commissioner of agriculture to establish and maintain at some central point, a station for experimenting in sugar-making from beets, sorghum or cane. Provision is made for educating in sugar-making processes, at this station, students who will agree to continue in the work for at least three years after leaving the station. Each state will be entitled to send two students, and the territories and District of Columbia, one each.

The first bulletin issued by the West Virginia station relates to the organization and work. At the time this bulletin was supposed to be issued (July, '88) there was no station in any sense of the word, being no buildings, land or money (outside of the Hatch fund), and no staff, or place to locate in. However we note that the dairyman is A. C. Magruder; meteorologist and assistant chemist, A. R. Whitehill; microscopist, J. W. Hartigan, and ornithologist, W. D. Doan. We note with pleasure that the director, J. A. Myers, says "that our station laboratory is not intended as an advertising medium for mineral springs, minerals or mining schemes."

The 60th bulletin from the North Carolina station devotes most of its space to the subject of lucern. But little original matter is present, the station work being mainly a study of the roots, of which two illustrations are given. Abstracts are also given from newspapers and reports, concerning the value of this plant. We believe that too much stress is laid upon its worth, inclining to exaggeration in the quotations. From several years experience with this plant, we do not believe a crop can be harvested within eight weeks of cutting—at least it must be termed an apology for a crop. In our experience, like most clovers, this plant does but little the first year, when seeded down.

Prof. Sanborn has contributed some instructive and valuable facts concerning the use of harrows, to bulletin four of the Missouri station. The following are the implements tested with the Baldwin self-registering dynamometer: Randall, Acme, spring tooth, square tooth and smoothing harrows, Lubin pulverizer, the Albion, Tower and Eagle cultivators. The Acme gave 20.5 per cent. the total draft of seven machines compared, on unplowed corn ground, while on plowed corn ground it required but 14.53 per cent. total draft of all machines. In depth of tillage the Randall made the best showing, as the draft per square inch of soil turned is 1.83 lbs. less for it than any harrow, excepting the smoothing. It is particularly strong on sod. Ridging the land is its one weakness. The spring-toothed harrows (Walking and Albion) leave the earth more compact than the others, and do not cut so deep as the Randall by 25 per cent. The smoothing harrow, with slanting teeth, goes easier, shallower and leaves the soil looser than when straight, but does not fine it as well. The square teeth go deeper, draw easier and fine the soil better than the round teeth set straight, while both draw easier than any other machine. The objection to using them is that they till shallow and leave the soil compact. This is a bulletin that contains matter which farmers ought to know.

The third bulletin of the Cornell university station contains matter of striking value to both the entomologist and practical farmer. It is devoted to three subjects. First. *The insectary of Cornell university*. This insectary is shown in an excellent reproduction from a photograph. It is a small two-story cottage with conservatory attached. In the cottage on the first floor is a laboratory for the experimenter and his artist, a work shop, and a dark room for photographic purposes. In the second story are janitor's quarters, and store room for apparatus. In the basement is a boiler for heating the conservatory and building, conveniences for potting plants, a coal cellar and cold room for the storage of hibernating insects. The conservatory is much the same as if for botanical purposes. Among the equipments, is a new breeding cage, termed a root cage. It consists of a frame holding two plates of glass in a vertical position, and only a short distance apart. The space between the glass is filled with soil for planting. The space between the glass is regulated by the width of two strips of wood between them, one at each end, and can be varied as desired. Outside of each glass there is at each end a strip of wood for holding the glass in place, fastened by means of wedges. Moisture is allowed to pass out through the cracks between the glass and wood. Second. *On preventing the ravages of wire worms*. The bulletin describes and gives illustrations of wire worms and certain beetles found in the field. Experiments were made as follows in trapping the beetles of the wire worm—click beetles. Baits of sliced potatoes, clover, corn-meal dough and corn-meal dough sweetened with sugar, were placed in various positions in a badly infested field, soon after planting, before vegetation. In most cases the baits were placed on the surface, and covered with boards. Twelve traps, left undisturbed three days, yielded 482 click beetles. Three per cent. of all the beetles taken were in traps with unsweetened dough; 31 per cent. in sweetened dough and 65 per cent. where baited with clover. The clover baits were small bunches of about one-fourth pound weight of freshly cut clover. Of a series of 24 traps, examined at six P. M. and 6:30 A. M., 32.5 per cent of the beetles were taken during the day and 67.5 per cent. during the night. Traps were made by sinking shallow pie tins below the surface, so the edge of the tin was even with the surface, while cake tins not sunk at all, having edges three inches above the surface were used. In the sunken tins 87 per cent. of the insects were captured, and 13 in the deep tins. Clover dipped in Paris green water, poisoned the beetles. Third. *On the destruction of the plum curculio by poisons*. Prof. Comstock shows how plum curculios have been destroyed by applications of Paris green to fruit trees, and advises using one pound to 100 gallons of water and apply by means of a force pump furnished with a spray nozzle.

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# THE DISTRIBUTION OF STARCH IN THE POTATO TUBER.

BY E. S. GOFF.

In order to discover if the distribution of starch in the potato tuber is capable of furnishing a clue to a rational method of cutting potatoes for seed, the comparative amounts of this material contained by various parts of healthy tubers was ascertained by determining the specific gravity of the different portions.[1] This was accomplished by weighing sections of tubers upon a spring balance, which was tolerably accurate to the tenth of a gram, first in the air and then in distilled water, after which the weight in the air was divided by the loss of weight in water.

The weighings were made Jan. 11 and 12, 1889. The potatoes used were in every case of the white star variety, and were sound tubers of medium size that had been stored since they were dug, in October last, in a dark cellar that was rather damp and warm. The effort was made to secure specimens of which the skin was quite uninjured either during handling, or from the potato scab, but as this appeared to be impossible, samples were chosen that showed the least injury from these causes.

The first comparisons were between the "seed-end" or apical end of the tuber, and the "stem-end," or the end to which the stem is attached.[2] The tubers were divided transversely near the center, and the specific gravity of the two parts was determined separately. The results secured were as follows :

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[1] "According to J. J. Pohl (Wein. Akad. Ber. viii, 42; Jahresb, 1852, p. 11), the percentage of dry substance and of starch in potatoes varies with their specific gravity." Watt's Dict. chem., iv, 721.

"The specific gravity of potatoes is found to be approximately proportional to the quantity of starch they contain." Frankland, Ag. chem. anal., 174.

[2] The agricultural terms "seed-end" and "stem-end," which have a definite meaning to the potato grower, are here employed for convenience.

| | No. of tuber. | Seed-end. | | Stem-end. | |
|---|---|---|---|---|---|
| | | Weight. Grams. | Specific gravity. | Weight. Grams. | Specific gravity. |
| | 1 | 37.6 | 1.1090 | 28.0 | 1.0895 |
| | 2 | 56.4 | 1.0994 | 54.1 | 1.0907 |
| | 3 | 62.8 | 1.1105 | 57.7 | 1.0990 |
| | 4* | 45.9 | 1.0825 | 38.5 | 1.0845 |
| | 5 | 43.3 | 1.0907 | 37.0 | 1.0819 |
| Average................ | | 49.2 | 1.0984 | 43.06 | 1.0891 |

* The skin of this tuber was slightly broken near the stem end.

It appears from the average that the specific gravity of the seed-end was appreciably greater than that of the opposite end, which indicates a larger deposit of starch in that portion of the tuber.

In the next trial, two transverse cuts were made through the tubers, dividing them into three parts, intended to be nearly equal as judged by the eye. The following table shows the specific gravity of the sections :

| No. of tuber. | Seed-end. | | Center. | | Stem-end. | |
|---|---|---|---|---|---|---|
| | Wt. Grams. | Specific gravity. | Wt. Grams. | Specific gravity. | Wt. Grams. | Specific gravity. |
| 1............ | 34.9 | 1.1044 | 44.5 | 1.1069 | 34.6 | 1.0915 |
| 2............ | 49.6 | 1.0973 | 47.6 | 1.0993 | 35.1 | 1.0734 |
| 3†.......... | 48.7 | 1.1144 | 55.0 | 1.1066 | 41.5 | 1.0696 |
| 4............ | 33.5 | 1.0984 | 55.7 | 1.1019 | 50.2 | 1.0866 |
| 5............ | 35.3 | 1.1057 | 40.3 | 1.0951 | 32.7 | 1.0514 |
| Average...... | 40.4 | 1.1040 | 48.62 | 1.1019 | 38.82 | 1.0745 |

† The seed end of this tuber was slightly injured by abrasion.

In this test, the specific gravity of the center exceeded that of the seed-end in three cases, while the average shows a slightly higher specific gravity for the latter. It is quite possible that the number of tubers operated upon was not sufficiently large. The specific gravity of the stem-end was very perceptibly lower than that of either the center or seed-end.

Two tubers were cut to single eyes in order, beginning at the stem-end, in the manner recommended by Dr. Sturtevant,[1] the knife used having a thin, concave and curved blade. The specific gravity of these single eye cuttings was then determined separately, and in the order in which they were removed from the tuber. The results given below, which are the average for the tubers, agree substantially with those secured in the preceding trial.

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[1] Report N. Y. agricultural experiment station, 1883, p. 128.

Seed-end 1.0853
1.1077
1.1061
1.1093
1.1053
1.0956
1.1027
1.1013
1.1042
1.1021
1.0979
1.0860
Stem-end 1.0762

In another trial, a longitudinal section was taken through the center of five tubers, by means of a brass cork-cutter, of which the inside diameter was about 1.7 centimeters. From each end of the cylinder thus formed, a short transverse section was then removed, so that the remainder represented the portion of the tuber corresponding to the pith of a stem. From the remaining portion of these tubers from which the pith sections had been taken, four or five transverse cuts were made near the center, forming slices from each of which the center had been removed by the cork-cutter. The portion lying outside of the line marking the cambium layer, in each of these slices, was next removed by cutting along this line with a thin knife blade. The specific gravity of the cylinder representing the pith, the portion lying outside of the cambium line, and the intermediate part, in five tubers, was then determined separately with the following results:

| No. of tubers. | Portion lying outside the cambium line. | | Pith. | | Intermediate portion. | |
|---|---|---|---|---|---|---|
| | Wt. Grams. | Specific gravity. | Wt. Grams. | Specific gravity. | Wt. Grams. | Specific gravity. |
| 1 | 47.7 | 1.0991 | 17.8 | 1.0887 | 35.3 | 1.0997 |
| 2* | 27.3 | 1.0920 | 13.0 | 1.0779 | 26.3 | 1.0868 |
| 3 | 22.0 | 1.0945 | 15.9 | 1.0890 | 20.9 | 1.1000 |
| 4 | 24.9 | 1.1018 | 14.7 | 1.0970 | 24.1 | 1.1357 |
| 5 | 28.3 | 1.0969 | 15.7 | 1.0903 | 25.6 | 1.1107 |
| Average | 30.04 | 1.0968 | 15.42 | 1.0885 | 26.44 | 1.1065 |

*This tuber was slightly crooked, hence the longitudinal section was taken from one side of the center in a part of its course.

From these figures, it appears that the part of the tuber richest in starch lies between the cambium layer and the pith, and that the pith is poorest in starch, while the starch content of the part lying outside of the cambium layer is intermediate between that of the other two.

To recapitulate, it appears from the determinations of specific gravity from various parts of the potato tuber, that the part richest in starch lies within the cambium layer, but adjacent to it, and that the portion of the potato lying near the seed-end is richer in starch than that lying near the opposite end. Let us now consider how far the productiveness of different parts of the tuber, as determined by experiment, correspond with their starch content.

Dr. Sturtevant[1] found that the seed-ends of potatoes yielded more than did the stem-ends. An experiment conducted by the writer at the New York agricultural experiment station during the year 1888, gave similar results.

Dr. Sturtevant[2] also found in repeated trials, not without an exception, however, that where the tuber was divided transversely into three sections, the central part yielded most, the seed-end second, and the stem end least. Similar results were secured when the eyes were planted in order, as described above.

It is quite evident that the notably greater vigor of the eyes at the seed-end as compared with those at the opposite end of the tuber cannot be accounted for by the slightly greater amount of starch deposited in that part of the tuber.

Referring to the object in view in making the determinations here recorded, perhaps the only clue furnished as to a rational method of cutting the tuber for seed is that it is probably better to cut the tuber longitudinally than transversely, as the latter method of cutting would unequally divide the nutriment contained in the tuber.

New York agricultural experiment station,
Geneva, Jan. 26, 1889.

## LETTERS TO EDITOR.

### SUGAR CANE SEEDLINGS.

We have come across a somewhat interesting point in connection with sugar cane, i. e., the possibility of the production of varieties of canes by the seeds occasionally produced on the cane-arrow or flowering stalk. We now have under cultivation ten varieties differing somewhat in their characteristics, from any previously grown here. We successfully raised about 60 seedlings, and at present are cultivating cuttings from them in order to examine more fully into their sugar producing capabilities. The experiment of course owes its interest to the general opinion that the sugar cane cannot produce fertile seed, an opinion which is not shared by our older planters here.

J. B. HARRISON.

Government Laboratory, Barbados, West Indies, Jan. 11, 1889.

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[1] Report N. Y. agricultural experiment station, 1882, p. 69.

[2] l. c., 1885, p. 48.

## RECENT LITERATURE.

SIXTH ANNUAL REPORT of the Ohio agricultural experiment station, for 1887, pp. 328. Columbus: 1888.

The report of this station for 1887 is very much delayed; certainly it would seem as though it ought to appear more promptly.

From page 10 to 193 is the report of the superintendent of field experiments, who records experiments as follows: wheat culture; comparative variety tests, thick and thin seeding, early and late seeding, seeding at different depths, methods of seeding, winter protection, special treatment in spring, fertilizer application, variety study, and tests at sub-stations. Experiments with oats involved tests of varieties, thick and thin seeding and tests at sub-stations. With maize, variety tests, at different depths and dates, distribution of seed, method of culture, different amounts of culture, and fertilizer application. In addition, the superintendent records experiments with mangel-wurzels and in pig feeding.

The horticulturist's report, which is largely a summary of the work done by that officer since the establishment of the station, and which pertains generally to tests of varieties of fruits and vegetables, with fertilizer experiments on vegetables, especially potatoes, extends from page 194 to 257.

It is to be regretted that the report of the chemist is not longer, as it contains some analytical work on fruits, a field but little touched as yet by chemists in America.

The most exacting critic must admit that this volume represents a vast amount of work. Wisdom has been shown by repeating many plat experiments, yearly, under as nearly as possible the same condition for each as existed in previous years. These experiments should be repeated, so that in time the results will have a more fixed value.

It is one thing to conduct an experiment, but quite another to properly interpret the results of the same, and draw conclusions and present them to the reader in such a manner as to make the deductions clear cut and serviceable to him. A mass of figures and tables is rarely used excepting by students especially interested, but the results briefly set forth in language are not so often passed by. This report is a good example of table presentation, a feature quite prevalent in station publications. It is true that often these tables should be published, but the experimenter should interpret them to the reader by means of drawn conclusions. We do not offer this criticism as only personal to the Ohio station, neither do we insist that tables should not be published. However, the latter should be made to serve an end not difficult to see.

We must insist, as in our review of the Ohio report for 1886, that the classification of wheat presented by the superintendent of field experiments, is not substantial, as the entire foundation is based upon the color of kernel. As all persons well versed in cereal culture know, the wheat plant is very susceptible to its surroundings. To illustrate, we have grown in the same variety, decidedly white, amber and red kernels, these features being influenced by climatic and other conditions. A pure white wheat from France or England, grown in America, may be a positive amber or red. In descriptions of varieties, we must certainly take into account color of kernel, but to base a classification on this feature is to make it worthless, if expressed in the mildest terms.

In conclusion, for the amount of money expended upon it, we believe no station in the country has given greater returns to its constituents than has that of Ohio.

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BARBADOS. Report of the results obtained on the experimental fields at Dodd's reformatory, 1888, pp. 37. By J. B. Harrison and J. R. Bovell.

COLORADO STATE AGRICULTURAL COLLEGE. The agricultural experiment station. Bulletin No. 6, pp. 24. Notes on insects and insecticides. January, 1889.

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CONNECTICUT, STATE OF. Annual report of the Connecticut agricultural experiment station for 1888. Part 1, pp. 87. New Haven : 1889.

CORNELL UNIVERSITY, college of agriculture. Bulletin of the agricultural experiment station. IV. December, 1888, pp. 49-61, plate 1.

DAKOTA AGRICULTURAL COLLEGE AND EXPERIMENT STATION, Brookings, Dak. Bulletin No. 8. December, 1888, pp. 14. Department of chemistry. The drinking waters of Dakota.

DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION. Bulletin No. 3. December, 1888, pp. 8.

FREAM, W. The herbage of old grass lands. From the *Journal of the Royal agricultural society of England*, xxiv, part II, pp. 33.

GEORGIA AGRICULTURAL EXPERIMENT STATION, at the state college of agriculture and mechanical arts, university of Georgia. Bulletin No. 1. October, 1888, pp. 8. Bulletin No. 2. January, 1889, pp. 9-42. Athens, Ga.

GEORGIA AGRICULTURAL EXPERIMENT STATION. First annual report of the, for 1888. To the governor, pp. 12.

ILLINOIS, First annual report of the agricultural experiment station of the university of, 1887-88, pp. 15.

IOWA AGRICULTURAL COLLEGE EXPERIMENT STATION. Bulletin No. 2, pp. 43. Ames, Iowa, September, 1888. First annual report of the. From March 1 to December 31, 1888. Des Moines, 1889, pp. 15.

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JAPAN. Imperial college of agriculture and dendrology. Komaba, Tokyo. Bulletin No. 3, pp. 38. Researches on the composition, treatment and application of night soil as a manure, and on the valuation of Japanese fertilizers. By Dr. O. Kellner, November, 1888.

KEW, Royal gardens. Bulletin of miscellaneous information. No. 26. February, 1889, pp. 29-56. Seeds of herbaceous plants.

LOUISIANA STATE EXPERIMENT STATION, Bulletin No. 19 of. Sorghum. Field, laboratory and sugar-house results. Diffusion process. Baton Rouge : 1888, pp. 165-194.

MASS. AGRICULTURAL COLLEGE, Hatch experiment station of the. Bulletin No. 3, January, 1889, pp. 20. Tuberculosis.

MASS. AGRICULTURAL COLLEGE. Meteorological observatory of the Hatch experiment station. Bulletin No. 1. January, 1889, pp. 8.

MINNESOTA, University of. Experiment station of the college of agriculture. St. Anthony's Park, Ramsey Co., Minn. January, 1889. Bulletin 5, pp. 67, illustrations numerous. Agriculture. Horticulture. Botany.

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION, Hanover, N. H. Bulletin No. 4. November, 1888, pp. 31. The science and practice of stock feeding.

NEW JERSEY AGRICULTURAL EXPERIMENT STATION. Bulletin LI, Dec. 31, 1888, pp. 32. Sorghum and sugar making.

PENNSYLVANIA STATE COLLEGE AGRICULTURAL EXPERIMENT STATION. Bulletin No. 6. January, 1889, pp. 16.

PURDUE UNIVERSITY. Bulletin of the agricultural experiment station of Indiana. No. 17. Parturient apoplexy. November, 1888, pp. iv, No. 18. Experiments with vegetables. January, 1889, pp. 11, No. 19. Spotting of peaches and cucumbers. January, 1889, pp. 12, No. 20. Experiments in cross-fertilization, and the culture of tropical ferns. January, 1889, pp. 11.

STONE, Ph. D. Winthrop E. Investigations concerning arabinose and some related substances. Knoxville, Tenn., 1889, pp. 26.

## ABSTRACTS.

### THE FUNGUS DISEASES OF CEREALS.

(By M. MILLARDET: *Jour. d'Agric. Prat.*, 1888, pp. 743-747.)

The author recounts the recent researches of Dr. O. Brefeld on the Ustilagineæ or smut fungi.

By prolonged cultivation of the fungus through many generations in nutritive fluids the sporidia finally lost their power of penetrating the host plant when sown upon it. The smut fungi always abound in barn-yard or stable manure and grow and multiply therein with great rapidity, the same as in artificial cultures. In fresh manure they are vigorous and capable of infesting grain plants, but later they appear to exhaust themselves and lose this power. Hence it is that old and well rotted manure is less dangerous to crops than fresh, as regards the smut fungi.

He cultivated at first, by the aid of nutritive liquids, spores of Ustilago. When he had obtained thus, cultures entirely free of all other organisms, he added the entire collection of these cultures, consisting of millions of sporidia to field crops through a spraying machine. Seeds of wheat, barley, rye, oats and maize in various stages of development, planted in white iron boxes in moist soil, with the aid of the machine, were given, either completely, or partially, a fine spraying, in the water of which were placed many fungi spores. The soil in the boxes was afterwards compacted to prevent humidity, and after some days, turned and exposed on the surface so that the plants would develop freely and normally up to maturity. Finally the smut appeared upon the panicles of those which had been infected. One lot of plants, similar to those sprayed, were used as checks.

Other infection experiments were tried, such as making the seed germinate in soil containing the sporidia, and in a mixture of the infected soil with fresh manure.

The infection of the oat with *Ustilago carbo*, is easiest, according as germination is least advanced. When the embryo first appears, the infection was 20 per cent.; when the young plants were two centimeters high, not more than two per cent. When the seeds where sown in soil infested with spores, the disease showed itself to the extent of four to five per cent., while infected soil mixed with fresh horse manure produced 46 per cent. diseased plants. Where infection was attempted with sporidia developed over ten months of culture, to their thousandth generation, no disease occurred.

The evil influence of fresh manure is shown in a striking manner, other than in the above case. The manure of the horse and pig was often found to contain seeds of oats and barley which had escaped mastication and germinated. In fields of beets, where many of these seeds germinated in the manure, the larger part of the plants became tainted with smut.

It was found that the tubes of the spores germinated on the primary root of the young plant. At first the interior tissues are filled with the parasitical filaments, later they appear in the stem, where they remain latent until flowering appears, when they rapidly develop in the head and swell up the ovaries, which finally burst and scatter the spores as a brown powder. When the spores in good condition, are deposited upon very young, germinating plants, they may develop and their filaments penetrate to a certain depth, causing atrophy of the parts.

When the parts of the plant are a little aged, the spores deposited thereon by the spraying machine are incapable of penetrating into the interior. Usually, after reaching a hight of three or four centimeters or more, the plant acquires immunity from the malady.

Rye and wheat smuts act in the same manner as does that of the oat. The same may be said of barley smut, excepting that it is caused by *Ustilago Hordeii*, Brefeld, instead of *U. carbo*.

Experiments were also tried, in infecting sorghum with *Ustilago cruenta*, which produces smut in that plant. When the young terminal bud of sorghum is sprinkled with the liquid containing the spores, after some days the green color of the young leaves, especially where touched with the liquid, becomes a sickly yellow. The microscope shows in the midst of the tissues a very great mycelium development, which devours the cells and stops leaf development. But this disease is local, and does not form smut tumors in the infected parts of floral organs. When new leaves are formed they remain healthy, while the old vegetation takes up its normal habit.

The development of *Ustilago maydis* in maize is very different from the above. In 1885, upon five per cent. of the young plants the disease appeared on the 16th day after the spores were all applied through the spraying machine. Smut tumors appeared near the base of the stem, and caused the death of the young plants, while the other 95 per cent. made a perfectly normal growth to the end.

The author concluded that, different from the preceding cereals, maize might become infected in any part of the plant, provided it was not too much developed. This proved to be true, as is shown below.

In the first part of June, 1886, young maize plants, were raised to about a foot in hight in a wooden box. By means of the spraying instrument, a considerable quantity of the infected liquid was deposited in amongst the young leaves. For ten days following this application, nothing abnormal happened, and the young leaves continued to develop vigorously. On the 12th day a discoloration appeared on the base of the young leaves where the liquid had touched. Examined through the microscope, the discolored points were found to be a mass of minute orifices, through which the germ tube of the spores had passed into the leaf. Within was found mycelium in abundance, extending in all directions. Little by little the discoloration of tissue developed, the mycelium became more prominent, so that, after another week, during which the plants had grown with great rapidity, the smut tumors had reached their complete development. All of the leaves were literally covered with a growth of tumors which renders them nearly unrecognizable, consequently the entire plants were distorted, and of frightful form. After the tumors, which developed with remarkable rapidity, had reached their growth, they changed from a whitish to a brown color, the latter being due to the formation of dark spores within.

All the plants, to the number of over 100, which had been operated upon, after four weeks, were diseased. The youngest had suffered the most. In the older ones, more developed, the disease remained localized in the superior parts; the inferior leaves, being already developed, were not infected, and served to nourish the plant. Six weeks after infection, the smut masses began to burst their contents, and shortly after, little by little the plants took on a normal development. During this time the female parts developed in the axels of the inferior leaves, which had not been struck with the smut, and developed, in the fall, a good number of ears covered with grain, in a perfect condition. The flowers of the male panicle, when touched with the liquid, if sufficiently developed, formed the characteristic smut tumors. Likewise, when the liquid struck the female panicle, in the early development, the same effect followed.

It is considered that the solution of sulphate of copper is the best remedy, by soaking the seeds of grain in it, before planting.

## RESEARCHES ON THE COMPOSITION, TREATMENT AND APPLICATION OF NIGHT-SOIL AS A MANURE.

(By O. KELLNER and Y. MORI: *Bulletin 3, Imperial College of agriculture and dendrology,* Japan.)

As night-soil is extensively used in Japan as a fertilizer, and as not a single analysis of the excreta of the various classes of Japanese people had been made, the authors took up the matter for investigation.

The excreta of four classes were examined, viz.: farmers living in the neighborhood of the city of Tokio, citizens, middle class officials, and soldiers and naval students who have a diet approaching that of Europeans. Comparing the value of the excreta from these people, in nitrogen, phosphoric acid and potash, the dung of farmers, who live mostly on vegetables, ranks lowest, while that of soldiers and naval students is richest, that from citizens and middle class officials being only a trifle better than the farmers.

The night-soil from people living on ordinary Japanese food is more dilute than that from mixed European diet. Eliminating the degree of dilution by calculating how much of the principal fertilizing compounds is contained in the night soil for every 100 parts of nitrogen, the following figures are given:

| | Phosphoric acid. | Potash. | Lime. | Common Salt. |
|---|---|---|---|---|
| From ordinary Japanese diet | 22.8 | 47.4 | 3.5 | 175.3 |
| " foreign styled food | 37.3 | 25.9 | 3.6 | 108.4 |
| " European diet | 37.1 | 30.0 | 12.9 | 94.2 |

In all specimens of excreta coming from Japanese food, potash and sodium chloride are present in larger proportions than in those examined in Europe.

Experience has taught the Japanese farmer not to apply night-soil in the fresh state to the crops. It is diluted with water 2–3 fold, and placed in tubs, where it decomposes till a greenish color appears on the surface, when the dung is considered ready for use. This greenish color is due to the dissolving of biliary products in the fæces. If the air is warm and the night-soil is not diluted, it will suffer a loss of nitrogen.

Interesting experiments were carried out to determine how much ammonia escapes from the dung, and the effect of temperature upon this loss. While the loss found was not great, in every trial the nitrogen diminished and the chlorine increased, according to the length of time the night-soil was exposed. After three weeks there had been lost from 100 parts of the total nitrogen applied, in winter 5.98, in spring 6.32 and in summer 7.5 parts. During the cold or moderately warm part of the year the losses of nitrogen gradually diminish as the storing is continued. The evaporation of ammonia is favored most by heat, hence the rate of evaporation cannot much decrease during the time of storage.

The water evaporation is not considerable, amounting to only 31.4 per cent. the total excreta after 11 weeks in spring, and 24.3 per cent. after five weeks in the hottest season of the year. The presence of a large proportion of soluble organic and inorganic compounds in the dung, is the principal reason for the very slight extent to which the water is lost.

Neither the fresh or decomposed excreta contain direct poisons to the plants, and the acid reaction occurring in fresh manure cannot disturb vegetation, as all ordinary soils neutralize the acid phosphates to which the reaction of the urine is due; further plants prefer acidulative to alkaline nutritive fluids. It seems as though the injurious action of the fresh excreta might be due to a soluble ingredient. Fresh dung is distinguished from decomposed, by its urea content, a soluble substance not likely to enter into chemical combinations in soils and be retained in the superficial layers in an absorbed state. To learn whether urea is capable of being absorbed or not, researches were undertaken on the subject, and it was found that soils did not have the power of absorbing it. The injurious effect of green manure is thus explained: As the urea remains in a dissolved state after top-dressing the crops, the concentration of the fluids in the soil may become so strong that the absorption of water by the roots is interfered with, whence the green organs are caused to wilt.

The application of fresh excreta is objectional from another point, viz.: the urea is liable to be washed down by rain, and carried beyond the reach of roots. Samples were taken, during calm weather, from different layers of soil on the college farm, and placed in sterilized flasks at once. A 200 c. c. sterilized urea solution was added to each. Ammonia determinations were made from time to time, from the flasks. Surface soil of a depth from 0–5 cm. had the strongest effect, between the ninth and 16th day of digestion, the urea conversion being finished; from a depth of 25–30 cm. the ammonification was soon perceptible, but continued very slowly and was not completed after two months; earth from deeper layers than the preceding ones still contained, after 37 days, all the urea applied. It is assumed that the capacity of soils imparted to them by micro-organisms for converting urea into ammonium carbonate gradually diminishes as the depth increases, and practically ceases below 50 cm.

From an agricultural standpoint, the following objections are made to using disinfectants on night-soil: (1) The excreta do not decompose, and the large urea content may in consequence cause crop injury and nitrogen loss; (2) excreta contain less fertilizing ingredients, as the disinfectant causes dilution; (3) the disinfectants may be injurious to the plants, thus seriously damaging the excreta for manure, excepting in special cases. The application of carbolic acid suspended the germinative power of wheat with a 0.1 per cent. solution and soy beans with a 0.05 per cent. solution

In field experiments with barley, a content of diluted excreta of 0.25 per cent. carbolic acid retarded germination, while one per cent. killed the seeds entirely. Ferrous sulphate chiefly acts as a deodorizer and does not interfere with the growth of crops.

In fertilizing effects, night-soil is poor in organic substances in relation to nitrogen. Where soil is very porous, human excreta has to be supplemented with vegetable materials, such as straw, chaff, leaves, grasses, etc.

To ascertain how far the relative proportion of the nutrients of the excreta coincides with the needs of crops, the maximum produce that can be obtained from the nitrogen of 1,000 liters of night-soil, provided the other nutrient exist in right proportion, in the field, is computed. As about 60 per cent. of the nitrogen passes into the crop, and as 1,000 liters of excreta contain 5.5 kilo. of this nutrient, there may be taken up by the crop 3.3 kilo of nitrogen. Of the 1.3 kilo. of phosphoric acid in 1,000 liters of night-soil only 0.20 kilo. can be actually absorbed by the crop. As only 15 per cent. of the phosphoric acid applied enters the crop, there ought to be contained in 1,000 liters of excreta, for barley, 7.13 kilo., or 5.83 kilo. more than exists, unless it is added. The excreta is also too poor in potash.

Hence it can be seen that human excreta do not constitute a complete fertilizer. The best way to regulate the deficiency is to supplement the ratio of nutrients in the excreta, by liberally adding rapidly acting phosphates and ashes. For cereals, roots and beets, such manures should be put in the furrows and well mixed with earth before sowing, and several repeated diluted doses of night-soil applied at sowing and during tillering. For leguminous crops only a slight supply of night-soil is recommended, but rather plenty of phosphates and potash top dressed.

## THE SOLUBLE CARBOHYDRATES OF SEEDS OF CERTAIN LEGUMINOSEAE.

(By W. MAXWELL. *Die Landw. Versuchs-Stationen*, xxxiv, p. 15.)

The term "dextrin" is frequently used in connection with analyses of vegetable matter, referring to certain soluble constituents which, after inversion with acids, reduce Fehling's solution. The glucose thus quantitatively determined, serves as a basis for calculating the amount of original "dextrin." The author has investigated the nature of the soluble substances in the seeds of certain Leguminoseæ.

The finely ground material was extracted three times with 70 per cent. alcohol, and the filtered extract heated to boiling with an excess of strontium-hydrate solution, by which a large precipitate was thrown down. After filtration this precipitate was decomposed with carbonic acid, and the solution filtered from the strontium carbonate. The filtrate was evaporated and extracted with 95 per cent. alcohol several times. In watery solution this product did not reduce Fehling's solution directly, but only after inversion. Finally crystals were obtained which agreed fully with those of cane sugar. These results were obtained with seeds of *Faba vulgaris.* In the same way cane sugar was found in the seeds of *Vicia sativa* and *Pisum sativum,* although less sharply characterized. In addition to this, a substance was found in *Faba* and *Vicia,* insoluble in alcohol on extracting the fluid obtained by decomposition of the strontium precipitate, but soluble in water. It did not reduce Fehling's solution directly, but after inversion did so. By treatment with nitric acid, it yielded levulinic acid and was undoubtedly a galactan.

Quantitative determinations were also made, but only with regard to the total amount of soluble carbohydrates, owing to the difficulty of separating the individual substances. A certain quantity of the finely ground material was extracted with water at 37°–40° C. and filtered, and the filtrate treated with a small quantity of phospor-wolframic acid, the precipitate filtered and the filtrate heated during three hours with hydrochloric acid. The glucose was then determined by tiltration with Fehling's solution.

Clearly, results obtained in this way can only be approximate, since by inversion a mixture of glucoses of different reducing powers are produced, viz., levulose and dextrose from cane sugar, galactose from the galactan and possibly others. The sugar obtained by inversion was therefore regarded as dextrose, and calculated to an original substance of the formula $C_6 H_{10} O_5$. The following average results must therefore be too low rather than too high:

| | | | | | |
|---|---|---|---|---|---|
| *Faba vulgaris* | 4.227 | per cent. | soluble | carbohydrate | $C_6 H_{10} O_5$. |
| *Vicia sativa* | 4.851 | " | " | " | " |
| *Pisum sativum* | 6.218 | " | " | " | " |

W. E. S.

## SYNTHETICAL EXPERIMENTS IN THE SUGAR GROUP.

(By E. FISCHER and J. TAFEL: *Berichite d. D. chem. Gesellschaft.* xx, 2566; xx, 3384–3390; xxii, 97.)

The efforts of these chemists to produce a true member of the sugar group, synthetically, have attracted much attention, corresponding, with their successive announcements to the literature of the last two years.

Starting with glycerine, two methods have been pursued which have led to the same result. By oxidation of glycerine with nitric acid and treatment with alkalies, and by treatment of acrolein-bromide with baryta, condensation products were obtained which closely resembled certain glucose bodies, more particularly so in their compounds with phenyl-hydrazin. This product is regarded as a condensation of two molecules of glycerine-aldehyde. Two isomers were obtained called α-acrose and β-acrose of which the former has been chiefly studied.

It reduced Fehling's solution readily by warming. Its phenylhydrazin compound melted at 205° C.—exactly that of the corresponding dextrose compound, but was optically inactive in distinction from the latter. When this "phenylacrosazon" was decomposed with hydrochloric acid a product was obtained similar in all respects to that obtained in a similar way from dextrose. This was completely reduced by acetic acid and zinc dust. After solution in alcohol, ether precipitated white, flocculent masses, which melted to a sirup on exposure to air. This showed the greatest resemblance to a natural sugar, tasted sweet, reduced Fehling's solution strongly, combined easily with phenyl-hydrazin and even *fermented with yeast*, apparently like dextrose or levulose. Unfortunately it was not noted if alcohol was formed by this fermentation. With sodium-amalgam it was reduced to a subtance with the formula $C_6 . H_{14} O_6$, which crystallized from an alcoholic solution and resembled mannit, except in being optically inactive.

The name *acrose* is given to this, the first hexatomic synthetic body susceptible to fermentation with yeast, and which, aside from optical inactivity, responds to the general reactions of the glucose group, dextrose, levulose and galactose.

W. E. S.

## THE HERBAGE OF OLD GRASS LANDS.

(By W. FREAM: *Jour. roy. agr. soc. of Eng.*, xxiv, pt. 2.)

Prof. Fream has been investigating the botanical composition of some of the old grass lands of England and Ireland. Pieces of sod two feet long, one foot broad and nine inches deep, from old pastures or meadows, were sent him from 25 localities, 17 being from England and eight from Ireland. These sods were planted on the college grounds at Downton, and the following observations taken: (1) the general appearance of each plant from time to time; (2) a note of every species of plant on each plat; (3) the total weight in grams of the cut herbage from each turf; (4) the actual weight, when exceeding one gram of each species of plant found in the herbage of each sod; (5) the calculated percentage by weight of each species when present in a significant proportion.

In 15 cases the gramineous herbage formed more than 50 per cent. of the total, and in the remaining ten cases the advantage was with the miscellaneous herbage.

*Lolium perenne* was first in importance in 21 cases, *Dactylis glomerata* in two, Agrostis sp. once, and a *Festuca ovina* var. once; not a single specimen of *Avena elatior* was found. Of the Leguminoseae, *Trifolium repens* ranks first, while it is worthy of note that *Medicago lupulina* was never once discovered.

The result of these investigations has been to provoke considerable controversy in the British agricultural press, as some prominent writers have contended that rye grass had no permanency, especially has Mr. Faunce de Laune objected to the use of rye grass in permanent grass land, through the same journal in which Prof. Fream publishes the results of his investigations. However, the work noted, has demonstrated in a most positive manner that the great basis of some of the best and oldest grass lands of England and Ireland is *Lolium perenne*.

## EXPERIMENTS ON SUGAR CANE.

(By J. B. HARRISON and J. R. BOVELL: *Rept. exper. fields at Dodd's reformatory*, pp. 37.)

These experiments were conducted on the Barbados islands.

Twelve experiments to ascertain the rate of loss in weight by keeping over periods of five to 11 days, gave an average loss of 1.04 per cent. per day, and much greater immediately after cutting than later on. There was also a loss of sugars by keeping.

In the application of manures to the canes, as in previous years, the addition of nitrogen to the phosphates and potash, greatly increased the yield, the increase varying with the amount of nitrogen used. The increase of nitrogen, when to the extent of 40 lbs. per acre, has also increased the sugar content in the cane and cane juice, as compared with those given only purely mineral manures. Sulfate of ammonia gave better results than nitrate of soda, the latter losing its influence after a short time. Experiments with dried blood alone, and dried blood with sulphate of ammonia did not give as good results as did the more active manures. The greatest apparent profit, in all cases, came from using sulfate of ammonia rather than nitrate of soda. A large increase of produce was obtained by manuring with sulphate of ammonia and potash, and the increase more than doubled by the addition of 200 lbs. per acre of superphosphate, but where more than this amount was used, the increase was lessened. Sulfate of ammonia and sulfate of potash gave a greater return than the ammonia and superphosphate.

Regarding the effect of potash application, it is concluded that the addition of potash to manurings of superphosphate and nitrogen may produce in soils at all deficient in available potash, large increase in the yield of canes and especially in the available sugar in the juice per acre. And that the presence of an excess of potash in the manure does not injuriously affect the purity of the juice, either by increasing the glucose or appreciably the amount of potash salts contained in it.

## REMEDIES FOR ANTHRACNOSE.

(By M. OREILLARD : *Progrès agricole et viticole*, vi, pp. 66–68 and 106–109.)

The author's vineyard had suffered much from the destructiveness of anthracnose, so much so that he was unable to harvest Balzacs, white Manceps, etc. In 1886 he began experimenting with washes, using Bordeaux mixture, with which he stopped the injury.

Afterwards the following mixture was used with great success :

| | |
|---|---|
| Sulfate of iron | 25 kilos. |
| " copper | 10 " |
| Water | 100 liters. |

This solution is carried by a woman, who sprinkles it with a brush, among the vines and on the ground, occasionally stirring the mixture. An active woman could thus cover 600 to 800 vines per day.

By means of this solution, in both 1887 and 1888, the anthracnose was completely checked or prevented, and those varieties which had previously lost all, bore bountifully of superb fruit. Further, this wash drove away snails and slugs, and destroyed insects which hibernate under the bark, and also mosses. In cases where chlorosis had usually weakened the vines of red grapes upon white soils, the use of this solution had given good results.

In one vineyard, treated with sulfate of carbon and Bordeaux mixture, the plants did not have the beautiful healthy green color that occurred where the iron-copper wash was used.

Most excellent results were obtained in the use of the following mixture by M. Marius Thomas, of Toulouse :

| | |
|---|---|
| Water | 100 liters. |
| Sulfate of copper | 14 kilos. |
| " iron | 20 " |
| Lime | 12 " |

While experiments in the use of sulfate of iron have been tried, in a number of cases it is demonstrated that it is not nearly so efficacious as a mixture of the sulfates of iron and copper.

## RESEARCHES UPON THE TRANSFORMATION OF FORCES AND MATTERS IN VEGETABLE RESPIRATION.

(By H. RODEWALD: *Pringsheim's Jahr.*, xix, pp. 221–294.)

The object of experiment, which was always with the thick, succulent stems of the radish-cabbage, was placed in a closed cylinder containing a small quantity of baryte water, and bearing a manometer or instrument for measuring the density of the air.

In order to determine the carbonic acid ejected, it was titrated with baryte water ; the manometer registering a diminution in pressure which permitted determining the quantity of oxygen absorbed.

It is clear that this method presents causes of error, which the author discusses carefully, after having made the necessary corrections.

It was shown, in five series of experiments, that the quantity of carbonic acid passed off and of oxygen absorbed are nearly equal, the relation $\frac{6o^2}{O}$ being equal to 1.061. It is thus clear that the greater part of combustible matter, destined to serve as food in respiration is furnished by the carbohydrates. As dextrine and starch are wanting in the radish-cabbage, and glucose is very abundant, it must be this sugar which enters into the respiration, and which adds perhaps a small quantity of substances other than oxygen.

The liberation of a cubic centimeter of carbonic acid ($CO^2$) corresponds to 4.37 calorics, and the absorption of a cubic centimeter of oxygen ($O^2$) to 4.46 calorics. In burning glucose, one cubic centimeter of carbonic acid corresponds to 4.95 calorics.

*Ab : Annales agronomiques, xiv, p. 526.*

## NUTRIENT FOOD MATERIAL OF BEES.

(By A. VON PLANTA : *Zeit. F. Phys. Chemie*, xii, p. 327.)

The author made an examination of the food provided by the "nurses" for the larvæ of bees ; and found that for queens, 69.38 per cent., for drones, 72.75 per cent., and for workers, 71.63 per cent is water. The chemical composition of the remaining solids is given below :

| | Queens. | Drones. (1-4 days). | Drones. (After 4 days). | Workers. |
|---|---|---|---|---|
| Nitrogenous substance | 45.14 | 55.91 | 31.67 | 51.21 |
| Fatty | 13.55 | 11.90 | 4.74 | 6.84 |
| Glucose | 20.39 | 9.57 | 38.49 | 27.65 |
| Ashes | 4.06 | —— | 2.02 | —— |

As the food varies in composition, the author is inclined to reject the theory that we have here to do with a secretion analagous to that of milk, and to support the theory of Schönfeld that the food comes from the stomach, and that its composition and degree of digestion are varied by the bee according to the age and sex of the larva.

*Ab. : Jour. roy. micros. soc., 1888, p. 942.*

## PERONOSPORA VITICOLA.

(By G. CUBONI : *Atti Congr. Naz. d. Bot. Cirtt.* Parma, 1887, pp. 20.)

This parasite of the vine occurs in two forms : (1) "forma palese," on the flower-stalks, either before or after flowering, numerous conidiophores appearing through the stomata, and causing the flower or young fruit to perish ; and (2) "forma larvata," on the fruit when nearly ripe, bringing about its discoloration and decay: in this latter form no conidia appear, but the pulp is permeated by the characteristic unicellular mycelium with its globular haustoria and chamber-like prolongations. Infection takes place on the flowerstalks by the conidia formed on the leaves; the fungus spreads from them to the berries, and not from the berries backward on to the axis. Sexual organs are never found on the fruit. The mycelium appears to retain its vitality for a long time in the dead fruits. The remedy recommended is copper sulfate, which prevents the germination of the conidia on the flower stalks.

*Hedwigia, 1888, p. 210.*

## OCCURRENCE OF STARCH IN THE ONION.

(By A. B. RENDLE: *Annals of botany*, ii, pp. 225–7.)

The statement is made that the leaves of the onion are known to be somewhat exceptional in that they do not form starch in the process of assimilation; glucose, which is present in large quantities in the mesophyll-cells, apparently taking its place. From the papers of Böhm, Schwiper, A. Myer and others, it would appear that the green leaf of the onion does not form starch at all. From the author's experiments, however, it is evident that the onion is rather to be considered as an extreme instance of a plant like *Euphorbia Lathyris* where the starch is present almost exclusively near the vascular bundle and at the base of the leaves; since, at any rate in seedlings, starch occurs under natural conditions in the same position as in this plant.

*Ab.: Jour. roy. micr. soc., 1888, p. 983.*

## THE CAUSE OF THE ABSENCE OF NITRATES IN FOREST TREES.

(By M. E. EBERMAYER: *Berich. d Deutsch. bot. Gesellch.*, 1888, p. 217–221.)

Many observers have learned in the present days that the aerial organs of ligneous plants never contain nitrates. It is probable, however, that they are gathered by ligneous plants, trees, and shrubs in cultivated forests.

The author sought for nitrates in forest soil rich in humus and also in the water which passes through such soil. He tested them with diphemylamine, which, used with sulfuric acid, gave a blue coloration in the presence of nitrates. He found that forest soil was entirely lacking in nitrates, or contained only a trace. Trees cultivated in a field well manured, or in a garden, always gave the nitrate reactions.

*Ab.: Annales agronomiques, xiv, p. 571.*

## AGRICULTURAL SCIENCE NEWS.

A bill has been introduced before the Victoria, Australia, legislative assembly, to make inoculation compulsory for pleuro-pneumonia.

The Iowa agricultural college has issued a pamphlet containing 12 excellent photo-engravings of the buildings and rooms of that institution, with accompanying text.

The proceedings of the Columbus, Ohio, horticultural society for 1887 have appeared in a very tasty volume, the contents of which reflect much credit to the society. The errata, however, indicates some very careless previous proof-reading, while the tardiness with which the report appears is great.

Dr. H. Müller shows (*Landwirth, Jahr.*, 1888, 83-160) that "Edelfäule" in grapes is caused by the attacks of a Botrytis, the *B. acinorum* of Pers., but identical with *B. cinerea.* Attacking the unripe berries in wet, but only the ripe berries in dry weather, it kills the epidermal cells, increases evaporation, and concentrates the juice. It takes up sugars and acids, decomposes them in respiration, and diminishes them in consequence in the berry. The sugar increases.

According to *Progrés agricole et viticole* (vi, p. 6) an experiment was made at the St. Rémy's school of agriculture, upon the effect of the temperature of drinking water upon the production of milk in cows. Two milch cows of the same age and producing nearly equal quantities of milk, were given the same food, excepting that one was given ice cold water, and the other water at a temperature of 45 degrees. The cow receiving the warmed water gave a greater weight of milk than did the other. A similar experiment was made at the Parc de la Tête d' Or, by M. Cornevin, professor in the veterinary school, with identical results.

The following matter quoted from the *Farmer's review*, gives interesting matter concerning agricultural schools in Austria during the year 1886. There were 81 schools of agriculture and forestry containing 2,572 pupils; about 20 winter and preparatory schools; and 565 improvement schools, teaching 15,000 pupils. The last are intended for the sons of small farmers who cannot attend the other institutions. They have gardens attached to them for instructions in botany and other subjects. Up to 1886 the schools—exclusive of the last class—had cost £922,535 for establishment and maintenance, of which the state finds £249,102. In further aid of agricultural education, traveling lecturers are paid by the ministry of agriculture, and 887 agricultural libraries have been established or assisted by the same state department. Breeding, land improvement, and other branches of agricultural development are also assisted by state funds. The outlay on agriculture, mining, and woods and forests is over £1,000,000 a year; but a good deal of this is recovered by the sale of produce. The average net expenditure of the ministry of agriculture since 1881 has been £331,293 per year.

In bulletin three of Imperial college of agriculture and dendrology, at Tokio, Japan, Dr. Kellner gives interesting information concerning Japanese fertilizers and their valuation. The concentrated fertilizers, Chili saltpeter, sulfate of ammonia, Peruvian guano, superphosphates. Thomas phosphate, potash salts, etc., are almost unknown to Japanese farmers. The only trade in fertilizers in Japan is in dried fish, various kinds of bran, oil cakes, wood and straw ash, lime and night-soil. Night-soil is especially valuable. In the vicinity of towns and cities farmers agree with house-holders and purchase the excreta of a family for a sum dependent upon the number of its members. In the agreements with families in Tokio, persons above 15 years are counted as adults, children between 10–15 count as one adult, while children below 10 are not included. About this city from 25–30 sen. ($1.=100 sen.) is paid per year for the excreta of an adult. The total quantity of dung deposited per year per head in the closet of each house may be estimated at about 100 Kuwamme, which after it is carried to the farm is worth about one yen (80 cents). Under present conditions, the excreta of the population of the towns and cities are by far the cheapest manure obtainable.

Dr. Germont and M. Loir, two of Pasteur's representatives, under the supervision of a committee comprising representative stockmen from different parts of Australia, the government analyst, chief inspector of stock and government veterinarian, conducted some experiments in Australia on the prevention of anthrax by inoculation with Pasteur's vaccine. Thirty-nine sheep and six cattle were procured from an uninfected district, and taken to Junee, where fitting preparations had been made. On September 4, twenty of these sheep were hypodermically injected in the inside of the thigh, with about two minims of Pasteur's first vaccine, and four of the cattle were similarly inoculated with about double the dose, immediately behind the shoulder. The temperature of the sheep, which was at first about 103, on the next and following day rose to 104, and in some cases reached 104.8, subsequently becoming natural. There was not much increase in the temperature of the cattle, and no abnormal symptoms were noticeable in either class of patients. On Sept. 18, the second vaccination was effected in the same manner. A similar advance of temperature was observed for three days, in several of the sheep reaching 105 and in two 107. The four cattle also had their second protective vaccination. The vaccinated and unvaccinated animals were pastured together, without the latter showing any bad effects. In preparation for the final test, two unprotected sheep were inoculated with virus procured from an outbreak which had occurred in the previous May, and which testified to its continued efficacy, by both sheep dying in 32 hours, their spleen exhibiting the characteristic lesions, and their blood containing anthrax bacilli. Three other sheep were subsequently vaccinated with the same virus, and with the same results. On Oct. 2, the twenty protected sheep and four protected cattle, with the 19 sheep and two cattle, unvaccinated, were inoculated, an animal from each lot being taken alternately. Two minms of blood of one of the sheep recently dead from the anthrax were injected, as before, into the thighs of the sheep and the shoulders of the cattle. The animals were then turned into the same enclosare, supplied with the same food, and watered together. Twenty-seven hours after the operation, the first of the unprotected sheep died. and the last survived just sixty hours. Both the unvaccinated cattle were very ill, and one died, the other gradually recovering. All the animals furnished ample evidence of anthrax, and in all the bacilli were found in the blood. Although the protected animals throughout hearded with those dying, and ate green food scattered in the paddock, and which sometimes was contaminated with the discharges of the infected, not one of them suffered in the slightest degree. Several days later some of the protected sheep were slaughtered, careful post-mortem examination was made, and the blood subjected to the microscope, but no evidence of anthrax was found. The board arrived at the conclusion that M. Pasteur's vaccine of anthrax is a preventive against that disease, and recommend its adoption and use.

# EXPERIMENT STATION ITEMS.

Prof. Wm. R. Dudley of Cornell university is to study the fungus diseases of plants under the direction of the Cornell station.

Mr. L. F. Kinney, a graduate of the class of 1888 of the Mass. agricultural college, has been elected horticulturist to the the Rhode Island station.

Dr. W. E. Stone, chemist to the Tennessee station, has published in pamphlet form his "investigations upon arabinose and some related substances."

An effort was made in the last Congress to convey the seed distribution from the United States department of agriculture to the several state experiment stations.

The first annual report of the Illinois station covers 15 pages. It describes the organization, outline of work, with experiments under way, and closes with a rather detailed financial statement.

Bulletin one of the Georgia station gives the organization and history, and prints the Hatch act. For 16 years experiments have been performed on the university of Georgia farm, according to Dr. Jones the director.

Mr. E. S. Goff, horticulturist to the New York agricultural experiment station, at Geneva, has been elected professor of horticulture in the university of Wisconsin, and horticulturist to the Wisconsin station, to take effect April 1.

Persons interested in the drinking waters of Dakota will find information pertinent to the subject, in the unpaged bulletin, numbered nine, from the station of that state. It is a bulletin that will certainly interest those the waters of whose wells have been analyzed.

The bulletin of the Royal gardens, Kew, for February, contains a list of such hardy, herbaceous annual and perennial plants as have matured seeds under cultivation there during the year 1888. These seeds are available for exchange with colonial, Indian and foreign botanic gardens.

Prof. G. H. Whitcher gives much valuable information on "the science and practice of stock feeding," in bulletin four of the New Hampshire station. This does not embody original research, but gives information concerning stock food, its composition and its application on the basis of feeding standards.

The annual report of the Connecticut station, at New Haven, for 1888 is issued in two parts. Part I is issued in advance of II, and relates entirely to fertilizers, or more properly the work of a fertilizer control. Fertilizer laws and much valuable information regarding fertilizers is given. During the year 244 fertilizers and 130 samples of feeding stuffs were analyzed at the station.

The department of botany and plant pathology of the Delaware college experiment station furnishes the material for bulletin three of that station, giving brief notes on the external characters and treatment of the black rot of grapes, grape mildew, apple and pear scab, strawberry blight, peach leaf curl and grain smut. The material presented is matter that has already been published elsewhere.

The first annual report of the Georgia station embraces 12 pages, and briefly notes the resources and expenditures of the station. The main building is 100x40 feet, three stories high. A two story dairy, 24x16 feet, on the Cornell plan, has been erected, and also a cow barn and plant house, for experimental purposes. A very complete meteorological outfit has been secured. The chemical laboratory of the university of Georgia serves in the main for chemical work. We note that but $550 is expended on salaries, quite a contrast with some stations.

The sixth bulletin from the Colorado station is of a serviceable character, dwelling as it does upon insects and insecticides. It is notable that during 1888 the garden web worm (*Eurycreon rantalis*), squash bug (*Coreus tristis*) and the false chinch bug (*Nysius angulatus*), first appear in that state. The insecticides mentioned are the arsenites, white hellebore, pyrethrum, Ongarth's tree protector, kerosene. Brief notes, with remedies, are given on the following insects: *Eufitchia, ripearia Pieris rapæ* and *Protodice Coreus tristis, Carpocapsa pomonella, Graptodera foliacea, Alypia octomaculata, Ægeria, tipuliformis, Eurycreon rantalis, Bruchus pisi, Nysius angustatus*, and forest tree and miscellaneous insects.

"Tuberculosis" is the title of the third bulletin from the Hatch station of the Mass. agricultural college. It is by Prof. C. H. Fernald, the entomologist, and is an interesting *resumé* of this disease as it exists in man and the domestic animals. The following points are touched upon :, history, distribution, contagious character, identity of human and bovine tuberculosis, heredity, symptoms, remedies. The meteorological observatory of this station published bulletin one for January, giving the barometric record, reduced to freezing; wind; thermometer; hygrometer; clouds; rain and snow, and hourly reading from Draper's self-recording thermometer. The station is 260 feet above sea level, and the instruments 51 feet above the ground.

The sixth bulletin of the Pennsylvania station is by the assistant agriculturist W. H. Caldwell and relates to field crops, being mainly a test of varieties of wheat, oats, barley, potatoes and forage crops. Of six wheats, German emperor seemed most satisfactory. The Wide-awake oat was the most productive in grain of six varieties, while Manshury barley made a good record. What is called the college white potato did better than six others. On page 13 the statement concerning prickly comfrey, that it "has not as a general thing been grown successfully in this country," is not the fact, as it is one of those plants which grows almost too successfully, producing an enormous crop. Does not the writer mean it has not been used as stock feed successfully? which is so.

Bulletin two of the Georgia station opens on "factors in agricultural investigations" by the director. The writer endeavors to generalize upon plat experiments but we do not think with much success, especially in stating defects in results may be remedied by increasing the size of plats. The matter of plat experiments is undoubtedly a very knotty question. This bulletin contains a very excellent report upon ash analyses of native woods by the chemists, giving quite complete data in tabular form. The origin of soils is geologically considered by the geologist, the entomologist gives information concerning *Pieris rapœ*, and the director reports on some fertilizer experiments on cotton, and on a method of preserving sweet potatoes in winter. Certainly, the station will do a great work if it can devise a method of cheaply and satisfactorily preserving sweet potatoes for Georgia farmers, a very important matter. This is a creditable bulletin.

Bulletin three of the Alabama station contains the following: experiments with corn, ground peas, sweet potatoes; fertilizers for turnips; comparison of varieties of turnips; varieties of grapes; report of the chemist on fertilizers, minerals, soils, etc.; woods of Alabama; meteorological report. All the field plats, with the one exception of turnips are fertilizer tests. The plan of this station, of stating the object, etc., in few words, is good. But a valuable method of instruction is left out, when simply a table terminates the report. A concise conclusion as to results is of as much importance as the table. To be sure, remarks are occasionally made concerning results, but often experiments are reported in the bulletins of this station with a brevity that must greatly injure their value to the farmers of Alabama. They would read the conclusions, but dry tables will get slight attention. Further, no persons are supposed to be better prepared to interpret the results of experiments than are the very persons in charge of the stations.

The 19th bulletin of the Louisiana station gives the results of sorghum experiment. In Louisiana, the sorghum plant will produce a larger per cent. of success than in any other state, according to Dr. Stubbs. A number of varieties were planted, and tested chemically and in the diffusion battery. The season however was a most disastrous one, and this, coupled with delay in placing machinery, made the results unfortunate. The climate of Louisiana is such, that, in case sugar can be successfully produced from sorghum, the crop may be made to keep the mills busy six months of the year, instead of 60 days, as with sugar-cane. Many analyses were made of sorghum at different stages of growth. Diffusion juices contained less albuminoids than did mill juices. With a favorable season for investigation, this station will very likely secure valuable data regarding the practicability of making sugar from sorghum in Louisiana.

Bulletin two of the Iowa station, issued in September, 1888, contains information on the following subjects: Corn tassels, silks and blades. Proposed chemical work: Fodder analysis. Grasses and other forage plants. Chinch bug remedies. Arsenic experiments. Promising new cherries. The first annual report of this station briefly records, in 15 pages, the establishment of work at the station. The station has 80 acres of land. There was appropriated for a frame station house, $3,000.; for books, $2,000.; for chemical apparatus and other supplies, $2,500., and for two propagating houses, 11×30 feet, $750. An experimental orchard of six acres contains 75 varieties of apples, 25 of pears, and 45 each of plum and cherries; most of these being Russian fruit. The future work of the station will be specially directed to the producion of hardy and well adapted varieties of fruits, grasses and grains, by selection and cross-fertilization.

The fourth bulletin from the Cornell station discusses growing corn for fodder and ensilage in a manner that must suggest much to the reading farmer, being as it is, graphically illustrated. Ensilage corn grown in drills three feet apart, cultivated gave a 100 percentage yield, while that broadcasted, not cultivated, yielded 60 per cent. Analysis shows that in drills to have a higher feeding value than that grown in hills, broadcast, listed, etc., and as compared with Timothy hay at $12 per ton, it is worth almost twice as much per acre. The feeding value of corn fodder noticeably improves as it reaches maturity, jumping from $14.05 on July 24 to $47.33, on Sept 3. The effect derived from the use of commercial fertilizers on corn was not noticeable. An economic seed manure, so called, sold by Joseph Breck & Sons, Boston, Mass., was well exposed as of no more value than Bradley's super-phosphate though selling at 50 cents for four ounces or $4,000 per ton. The point made on Curwin's hog powder, is not strong, for no evidence whatsoever is damaging to the character of the powder. The analysis should have been supplemented with a practical test, even if it is presumable that the powder is valueless for the purpose advertised.

Bulletin five of the Minnesota station, issued in January, covers 67 pages and is well illustrated. The assistant in agriculture gives a careful description of the process of development of the maize plant, methods of planting and cultivation, with notes on ears and suckers. The main point of the writer is to prove that deep as well as early cultivation of maize is injurious through root pruning, if near the plants. He thinks it best not to break many roots. The horticulturist describes the method of making Russian willows and poplars from hard wood cuttings, illustrates and describes the native plums on the farm, and gives a test of cabbage varieties. In regard to cabbages, Early Wakefield is the best early, and Henderson's early summer second early. For late summer and fall Fottler's improved Brunswick and early late flat Dutch are recommended, while flat Dutch and Fottler's improved Brunswick are best for winter. The assistant in horticulture details an experiment in potato culture, the plan being to compare the crops from plants topped and untopped and rolled. The results were irregular. The botanist explains the phenomena taking place in freezing plants, and describes some species of rusts specially pertinent to wheat.

The results of the experiments in sorghum sugar work, conducted by the New Jersey station at Rio Grande, are given in bulletin 51 of this institution by Dr. Neale. The results were generally unsatisfactory, owing to crop failure in some instances, caused by late planting and early frosts, and lack of capital to procure certain necessary equipment in season. It was decided that the yield from each ton of sorghum, under normal conditions, should be 72 lbs. of pure sugar, or 83 lbs. of raw sugar, testing 86 per cent. Thirty-two pounds of extracted sugar should remain in the molasses, which, should approximate 11 gallons. In evaporating from the open pan, coal oil was used in place of steam, being passed through a red-hot iron coil and converted into illuminating gas. By this method the diffusion juice was reduced to less than one-half its original volume, and its purity decreased on the average by less than one degree. In 1887, sixty-five per cent. and in 1888, seventy-nine per cent. of the total sugar in the cane was extracted, a great improvement. The diffusion process, in 1887, diluted cane juice by 25.4 per cent.; in 1888 it was 28.6 per cent. A comparison is made of the diffusion battery at Rio Grande, as modified over 1887, with the German diffusion batteries used at Magnolia Station and Fort Scott, and it is decided that with the present arrangements at Rio Grande, using a Magnolia battery there would increase the expense account of 22 cents per ton of cane or nine dollars per day. The extraction by the Rio Grande apparatus is not equal to the German to a slight degree, and in this respect and purity of juice, there is very little difference in either form of battery.

Bulletin 17 of the Indiana station is by the veterinarian, Dr. Hinebauch, and discusses very briefly parturient apoplexy or milk fever. The causes, symptoms, treatment and prevention are given. Bulletin 18, by Prof. Troop, is on vegetable tests with fertilizers and varieties. The former tests, owing to drought, are termed "almost worthless." Varieties of potatoes, sweet corn, onions, peas, sugar beets and Japanese vegetables were studied. Bulletin 19, on the spotting of peaches and cucumbers, by Prof. Arthur, is an admirable combination of scientific and practical writing. A page description, with plan of the botanical department is given. The spot on the peach is a well known disease in Indiana, caused by the fungus, *Cladosporium carpophilum*, and has not heretofore been recorded as occurring in this country. The fungus makes discolorations about an eighth of an inch in diameter on the surface of the fruit, and is of a deep olive-brown color. No remedies have been tested. A description of the disease is given by von Thümen in Fungi Pomicoli, 1879, p. 13. A brief description is given of cucumber spot, a new Cladosporium, given the name *cucumerinum* by Ellis and Arthur. It has only been observed at Geneva, N. Y. Both of these diseases are well illustrated with drawings. Bulletin 20, by the florist, gives experiments in cross fertilizing chrysanthemums and carnations, and experiment in tropical fern culture. A number of hybrids were obtained in the crosses. A method of culture of *Adiantum cuneatum* by means of spores is given. This is interesting matter for florists, and to the credit of the station that this most important branch of experimental work is not being ignored.

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# EFFECT ON BUTTER OF FEEDING COTTON SEED, AND COTTON-SEED MEAL.

BY H. H. HARRINGTON.

In the *Analyst* (xiv, 153), A. H. Allen has an article "On abnormal samples of butter," in which is shown the small amount of volatile acids in certain samples of butter from the creameries in Denmark. In *Landw. Vers.* (xxxv, p. 261), A. Mayer, from an experiment on the "Influence of different cattle foods on the composition of butter," finds among other things, that the amount of $\frac{N}{10}$ alkali solution required for the distillate of five grams of butter, varied from 20 c. c. to 30 c. c.

At the time, and previous to the reading (Dec. 1888) of President Allen's paper before the "society of public analysts," I had begun work on samples of butter from the college creamery, which led me to doubt, particularly, the correctness of the uniform standard for genuine butter as reckoned by the quantity of volatile acids in two and one-half grams of butter, namely: the quantity of *vol. acids* in genuine butter, from two and one-half grams, should not fall *below* the quantity of acid necessary for neutralizing 12 c. c. $\frac{N}{10}$ alkali solution—conducted according the Reichert process.[1]

In the further examination of the butter, I found not only the amount of volatile acids small, but that the melting point was high, and that *saporification* was difficult. The cows that furnished this butter were fed on a mixed feed, and not entirely on cotton seed, or cotton-seed meal. I therefore took a sample of butter from a cow fed entirely on cotton seed, except a small amount of green grass gathered from the pasture, and for comparison, a sample from a cow fed no cotton seed; and sent a sample of each of these to Dr. Wiley, chemist to department of agriculture, Washington, with the request that he determine volatile acids in each.

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[1] See Prescott's Organic analysis, pp. 302-303; Allen's Organic analysis, vol. ii. pp. 45, *et seq.* 154-155.

He very kindly did this, and other investigations in addition, which he himself will describe. I then made examination of other samples of butter from cattle fed on cotton seed and with a very small amount of grass they could then get from the pasture. The figures are given below. It is now proposed to conduct an experiment on the influence of cotton seed, cooked cotton seed, and cotton-seed meal, as a feed, upon the milk and butter. The chemical work will be done jointly by Dr. Wiley and myself.

Sample of butter from cotton seed, No. 6316.

Sample of ordinary butter, No. 6317.

WILEY.

| | 6316 | 6317 |
|---|---|---|
| No. c. c. $\frac{N}{10}$ Ba. $O_2$ $H_2$ for 5 grams | 21 | 28.5 |
| Melting point | 45°C | 34.2.C |

HARRINGTON.

| | 6316 | 6317. |
|---|---|---|
| No. c. c. $\frac{N}{10}$ alkali for 2½ grams | 10.9 | 13.9 |
| Melting point | 45.3 | 3.4. |

Samples of butter from cotton seed, No. 6318.

Samples of ordinary butter, No. 6319.

| | 6318 | 6319 |
|---|---|---|
| No. of c. c. $\frac{N}{10}$ alkali for 2½ grams | 10.9 | 12.6 |
| Melting point | 45 | 34 |

Two other samples of all cotton-seed butter were examined, with 10.6 c. c. $\frac{N}{10}$ alkali for two and one-half grams, in each sample, and melting point at 47° C. I am fully convinced that the quantity of volatile acids will run much lower even, than this, where the cattle have nothing else as a feed but raw cotton seed.

Chemical laboratory, A. & M. college of Texas, March.

# ADDITIONAL NOTES ON BUTTER DERIVED FROM COWS FED ON COTTON-SEED MEAL.

BY H. W. WILEY.

Late in February, this year, I received a letter from Mr. H. H. Harrington, chemist to the experiment station of Texas, accompanied by two samples of butter which he asked me to examine. The following extract from Mr. Harrington's letter will indicate the motive which led him to send the samples. He says:

"Some work in our laboratory indicates that volatile acids from the cotton-seed butter are much lower than has been generally supposed. I send two samples of butter, one from cotton-seed feed and the other from feed containing no cotton seed. If you can do me the favor of analyzing this butter, I shall send more samples from the same cows on the same feed. We hope in the near future to follow up these analyses with complete analyses of butter from different feeds, feeding two cows on cotton seed and then changing them to other feed."

The two samples of butter received from Mr. Harrington were entered as follows:

| | |
|---|---|
| Butter from cotton seed. No. | 6316 |
| Butter from other feed. No. | 6317 |

The samples sent by Mr. Harrington were small and a complete analysis could not be made, but the results obtained on the small samples sent are of such interest that I will communicate them at the present time and call attention to the peculiarities noticed. When the other samples are received they will be examined and compared with the samples already analyzed.

RESULTS OF ANALYSES.

| | 6316 | 6317 |
|---|---|---|
| Volatile acids, No. c. c $\frac{N}{10}$ $BaO_2H_2$ for 5 gms | 21.0 | 28.5 |
| Percentage of iodine absorbed | 33.40 | 31.89 |
| Melting point | 45.°C. | 34°.2 C. |
| Reduction of silver by Bechi | distinct | none |

The most remarkable points conncted with the above analyses are as follows:

1. The low percentage of volatile acids in butter from cotton-seed.
2. The phenomenally high melting point of the butter from cotton seed.
3. The persistence of the reducing agent of the butter from cotton seed as indicated by its action upon nitrate of silver.

The melting point of the butter as will be seen is higher than that of pure lard. The particular point to be noticed in this matter is that in butter designed for consumption in southern countries, or produced in southern countries, the mixture of cotton seed with the feed of cows will tend to raise the melting point of the butter and render it more suitable for consumption in hot climates.

The persistence of the reducing agent is also a matter of interest. It has passed, in the samples examined, through the digestive organism of the cow and has reappeared in the butter with almost undiminished activity. The selective action of the digestive organs on the different glycerides contained in the food of the animal is also a matter of importance. It would be expected *a* *priori* that the butter from a cow fed largely on cotton-seed oil would contain more olein and have a lower melting point than if ordinary food were used. On the contrary it is seen that either the more solid glycerides have been absorbed during the process of digestion or that the olein has undergone some distinct change in the digestive organism by which it has assimilated the qualities of other glycerides.

From an analytical point of view the results are of great importance since they show that a butter derived from a cow fed on cotton-seed meal might be condemned as adulterated when judged by the amount of volatile acids present. Since cotton-seed meal is destined to be a cattle food of great importance, especially in the southern part of the United States, this is a fact of the greatest interest to analysts.

The observation of Mayer soon to be mentioned, that the specific gravity of butter fat varies with its content of volatile acids, I have also verified by the determination of the specific gravity of samples of butter fat taken from the milk of the same cows kept on the same food, but taken the following day, after the samples mentioned :

The sp. gr. for the cotton meal fed sample was................. .8929 at 99°
" " " ordinary " " " ............... .8991 " "

Prof. Mayer's experiments were made on a single cow of a North Holland breed. From time to time during the progress of the experiments the original food was used in order to see what effect the period of lactation would produce. The cow was fed for 12 days on each separate ration before the samples were taken. After two days more another set of samples was taken, and then the food changed for a new experiment.

In the butter fat the melting and solidifying points were taken, and the volatile acids determined, according to the method of Reichert. The specific gravity was also determined by the Westphal method at 100°.

The rations of the cow were composed of the following materials :

Ration No. 1. 15 kg. meadow hay and 2 kg. linseed cake.
Ration No. 2. Siloed grass, *ad libitum*, and 2 kg. linseed cake.
Ration No. 3. 20 kg. beets, 8 kg. hay and 2 kg. linseed cake.
Ration No. 4. Pasture grass, *ad libitum*.
Ration No. 5. Chopped clover with 14 per cent. of other grasses *ad libitum*.

The highest melting point observed, viz., 40.5 was from ration No. 1 ; and the lowest, viz., 32.5 from ration No. 5. The highest volatile acids were produced by ration No.3 and required 33.5 c. c. $\frac{N}{10}$ alkali. The lowest volatile acids, viz., 20 c. c. were observed with ration No. 2.

It has been the general opinion of practical butter makers, that the various physical properties which distinguish butters from each other, depend more on the method of manufacture than on the character of the food.

The breed to which the cow belongs is also known to affect the physical properties of the butter, and doubtless the chemical properties to some extent. Individual peculiarities of the animal also affect the character of the product, and when a single animal is used for the experiment the effect of bovine idiosyncrasy must not be lost sight of.

Allen[1] has called attention to some peculiarities of Danish butter, some of which contained volatile acid corresponding to only 22.3 c.c. $\frac{N}{10}$ alkali. This low content of acid is probably due to some peculiarity in the cattle food used.

Fleischmann in his work on dairying calls attention to the influence of certain kinds of food on the character of the butter. The data given by him are more of the nature of general experience than of exact scientific investigation.

In the great system of experiment stations established in this country we have at hand a fine opportunity to study this problem under varying conditions of climate and local influences, and we may expect soon to see great progress in lines of careful scientific research.

United States department of agriculture, Washington, D. C., March.

## LETTERS TO EDITOR.

### NOTES ON WISCONSIN WEEDS.

Wisconsin has a weed law which under penalties orders the destruction of certain weeds in roads and field. During the past season a lively discussion has been going on in a local agricultural paper in regard to enlarging and amending the law. Numerous parties in order to ascertain the correct names have sent specimens of weeds to this station for identification, and while the large majority of them were old time offenders a few were novelties to us.

From two sources in southern Wisconsin, nearly a hundred miles apart, came specimens of *Oxybaphus nyctagineus*. One party wrote that this pest grew so rank in a large corn-field that one could hardly make his way through the field because of it. I had always thought this plant rather rare in our flora and had never before heard complaints of its proving troublesome.

From three counties came specimens of *Cyperus phymatodes* with the complaint that this sedge had gained a foot-hold in cultivated fields and promised to make a persistent stand. I had supposed that our northern sedges only held in moist lands where cultivation of ordinary crops was out of the question. Gray speaks of the plant as "in low grounds along rivers, etc." Our reports are from upland cultivated fields. The numerous small nut-like tubers attached to the underground stems make it possible for the plant to spread through cultivated lands as rapidly as Quack-grass. Gray reports *Cyperus routundus* var. *Hydra*, an allied form, growing in sandy fields of Virginia and southward.

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[1] *Analyst*, January, 1889.

On the great plateau along the eastern flank of the Rocky Mountains, grows *Solanum rostratum*, a homely, harmless sort of plant. The naturalist knows it to be the original food plant of the Colorado potato beetle, *Doryphora 10-lineata*. In the year 1872 or thereabouts the beetle, coming across the uncultivated strip of eastern Colorado and western Kansas, found a new food plant in the common cultivated potato and spread with marvelous rapidity over the country. *Solanum rostratum* also comes into the fields to conquer and has spread on cultivated lands in Texas and Missouri where with greatly increased size it proves a troublesome weed. Last summer Mr. L. H. Pammel, one of our agricultural graduates, now professor of botany in Iowa agricultural college, found this plant growing at Watertown in this state. It is following up the potato beetle; will it spread over as large an area as its old congener?

*Cichorium Intybus* appears as a weed in the vicinity of Madison along road-sides, and has been reported troublesome from one other point in the state.

Squirrel-tail grass, *Hordeum jubatum*, is entirely too common along the road-sides and in old meadows. The numerous long awns which bend the heads of grass as they sway in the wind are very beautiful with a purple irridescence, at flowering time and are much sought for boquets but *the ripening heads are very unsightly* since the awns twist into all sorts of shapes and destroy the former symmetry.

The Canada thistle, *Cnicus arvensis*, is pretty well disseminated over the state, having been brought to us with grass and grain seed and also in packing-straw. In the interior of the state patches of this thistle can be found which vary from a few feet to acres in area. Skirting the shore of Lake Michigan is a strip several miles in width where this plant proves a terrible pest, and spreads rapidly. In this section the cooling influence of the lake is so marked that Indian corn does very poorly, and on many farms no attempt is made to grow it. Passing inland from the lake it would seem that the seeds of the Canada thistle do not usually ripen, or rather, are abortive. I have never seen a seed head of the Canada thistle in this vicinity that contained any perfect seeds and have similar reports from others. This important fact is probably due to our great mid-summer heat. Though present in many localities the spread of the plant from each center is very slow since it only goes on through the creeping root-stalks.

W. A. HENRY.

Wisconsin agricultural experiment station, March 9.

## THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

I should be sorry to have the words "colleges and" dropped from the name "association of American agricultural colleges and experiment stations" and to have the body made up, as you suggest, "simply of station directors and their assistants." The close relationship established by law between the colleges and the stations in most States makes it desirable, as it seems to me, to have an association in which both the colleges and the stations shall be represented in name and in reality. There were good reasons for giving almost exclusive attention to the stations, at the recent meeting; reasons which will probably not apply to the next meeting. The plan proposed by Dr. Armsby by which sections should be created within the present association I think much to be preferred to any one looking to dropping either the colleges or the stations from the association. With you, I regretted that so little was heard from some agricultural workers at the Knoxville meeting, but there was no college president there whom I would have wished "should remain in the background." To me, some of the most instructive and helpful words, and wisest suggestions of the meeting, were from men "known, if you please, as 'literary fellows.'"

G. E. MORROW.

Illinois agricultural experiment station, Champaign, Feb. 27.

## AGRICULTURAL SCIENCE IN EXPERIMENT STATIONS.

"Agricultural science" is a scarce article. The stations are more occupied in applying known science to agriculture, than in attempting to discover anything new. Few station workers have the skill or application necessary for original work. The public also is imperious in its demands, and most of the station officers are disposed to please the public, even at the sacrifice of work of permanent value. An editorial urging the importance of really scientific work and also showing what may be appropriately published in your journal and what in the regular bulletins might do good.

A. A. CROZIER.

Iowa Agricultural Experiment Station, Ames, March 12, 1889.

# EDITORIAL.

WHAT should the experiment station report be? is an interesting question, and one yet to be solved. Two forms of report are at present being issued from the stations, one giving a brief account to the governor, much on the same plane as a financial report, the other offering a detailed record of work in hand or accomplished. The former plan is to render the results of experimental work, in bulletin form, and issue the annual report as a mere statement. Technically speaking, this is perfectly legal. However, is this the most creditable and satisfactory way of publishing the results to the public? Heretofore, the bulletin has been called a "report of progress," and has served to satisfy a demand of the public, in informing them of what was being accomplished, and did not, as a rule, consist of technicalities. Now, it is proposed by some to make the bulletin the final report of the work in hand. If this is to be the case, then many bulletins will be likely to become the subjects of ridicule from farmers who, though anxious to learn, are unable to comprehend abstruse scientific detail. And yet the support of these farmers is desirable.

If interesting and valuable experimental results are published in bulletin form, in clear, brief, instructive language, they will carry weight and influence with them, but scientific detail of analytical work and multitudinous figures will not.

The annual report, we believe, should be a comprehensive account of the station work for the year, wherein all reported experiments may be discussed with as much fulness as the data will allow. If one is to be guided at all by precedent and practices of the most eminent station directors of this country, and so far as we know of Europe, he must concede that the annual station report embraces more than a brief statement to the governor, covering only a score of pages. It is not so much as to how narrowly we can construe the law, but rather, how broad is its application.

To go further, there should be experimental work done at stations, involving principles and producing results that from necessity would require elaborate study and discussion. While the facts deduced from such work should be presented to the public, the details, and their discussion, ought to be published in scientific journals, for the special benefit of investigators. In such contributions the author would feel perfectly free to be technical in his writing, being well aware that his audience were capable of comprehending his language. The very scientific reports of certain experiments in some station reports, outside of a few scientists, read like so much Choctaw to the possessors of the books. And yet there are station directors in the country who object to the subordinate officers publishing *elsewhere* than first in the station bulletins or reports, such scientific papers as we refer to, notwithstanding it does not make an iota's difference to the station or state.

The man of sense will approve of the most scientific work at our stations, but if he has to report upon it himself, he will endeavor to so frame his words and draw his conclusions that they may be intelligible to his audience whether scientific or practical.

## RECENT LITERATURE.

THE BOOK OF THE PIG: its selections, breeding, feeding and management. By James Long. London: L. Upcott Gill, 1886, pp. 360, fig. 42, plates, 25. Large octavo.

Written by an Englishman, and published in England, this book is in no sense local in its application, for the author has much to say concerning the pig in America, and in commendation at that. The book is finely illustrated by Harrison Weir, R. M. Wood and other artists, and a series of unusually good plates give plans of piggeries, among which are several of American breeders.

Such a volume as this should be better known in America, for it is plain, practical, comprehensive, and to the best of our knowledge, the most complete work on the pig in the English language, and furthermore is a beautiful piece of typographical work in large clear type.

## PUBLICATIONS RECEIVED.

ARKANSAS INDUSTRIAL UNIVERSITY, First annual report of the agricultural experiment stations of the. Fayetteville, Ark., 1889, pp. 134.

AUBURN, Ala. Bulletin No. four. New series. Agricultural experiment station of the agricultural and mechanical college, February, 1889, pp. 12. Strawberry culture. Grape culture and pruning. Raspberry culture.

COOK, A. J. The silo and silage, 1889, pp. 31. Lansing: D. D. Thorp, printer and binder.

DAKOTA AGRICULTURAL COLLEGE AND EXPERIMENT STATION, Brookings, Dak. Bulletin No. 9, pp. 8. January, 1889. Department of agriculture. Corn. Bull. No. 10. February, 1889. Department of forestry, horticulture and botany. The germination of frosted grain, pp. 8.

DELAWARE COLLEGE, First annual report of the agricultural experiment station of. Newark, Del., 1888, pp. 16.

GOODELL, Henry H. Reminiscences of the Orient, 26 pp.'

KENTUCKY AGRICULTURAL EXPERIMENT STATION, of the state college of Kentucky. Bulletin No. 16, pp. 22. Potato experiments. Lexington, Ky., December, 1888. No. 17, February, 1889, pp. 21. Corn experiments.

KEW, Royal gardens. Bulletin of miscellaneous information. No. 27, March, 1889, pp. 57-72.

MASSACHUSETTS STATE AGRICULTURAL EXPERIMENT STATION. Bulletin No. 32. February, 1889, pp. 12.

MINNESOTA, University of. Agricultural experiment station. Bulletin No. 6. February, 1889, pp. 28, plates 2. Experiments with frosted, rusted and stack-burned wheat.

NEBRASKA, University of. Second annual report of the agricultural experiment station o Nebraska, pp. 43.

NEW YORK AGRICULTURAL EXPERIMENT STATION. Peter Collier, director. The utility of experiment stations. Past and present work and future prospects of the Geneva station. An address delivered by Hon. W. W. Wright, member of the board of control of the New York agricultural experiment station, at the farmers' institute held in Geneva, Feb. 8-9, 1889, pp. 14.

NEW YORK AGRICULTURAL EXPERIMENT STATION, Peter Collier, Director. Bulletin No. 15, new series. November, 1888, pp. 103-116. Methods adopted for the systematic testing of new fruits. A circular to the originators or proprietors of new fruits. A list of fruits now under trial at the station. Geneva, N. Y.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION. Bulletin No. 61, pp. 53-84. December, 1888, January, 1889. XI. Composts-Formulas, analyses and value.

OHIO AGRICULTURAL EXPERIMENT STATION. Bulletin No. 7. Second series, December, 1888, pp. 91-110. Corn-Fertilizer experiments.

STORRS' SCHOOL AGRICULTURAL EXPERIMENT STATION, Mansfield, Conn. Bulletin No. 3. February, 1889, pp. 8, Roots of plants as manure. Meteorological observations.

STURTEVANT, M. D., E. Lewis. Paramount fertilizers, pp. 19.

TEXAS AGRICULTURAL EXPERIMENT STATION. Bulletin No. 4, December, 1888, pp, 18. Root rot of cotton or "cotton blight."

WISCONSIN, University of. Agricultural experiment station. Bulletin No. 18, pp. 35. Madison, Wis., January, 1889. The constitution of milk, and some of the conditions which affect the separation of cream.

## ABSTRACTS.

### LOSS AND GAIN OF NITROGEN IN AGRICULTURE.

(By B. FRANK: *Landw. Jahrbücher*, xvii, pp. 421-552.)

Among the sources of loss is the volatilization of ammonia from the soil. In some experiments in which ammonium sulphate solution was added to samples of soil, the author found that the ammonia thus added soon disappeared, being to a small extent converted into nitrates, while the greater part volatilized. A light and pure sandy soil does not expel the ammonia, and has only a feeble nitrifying power, so that the ammonium salt is retained nearly undiminished for a long time. Of the individual constituents, quartz grains and clay are inactive, while calcium carbonate causes both slow nitrification and also partial liberation of ammonia. Another source of loss was mentioned by Boussingault, viz., that when nitrates were given to plants growing in the dark, there was a liberation of free nitrogen, which he attributed to the action of some organic substance excreted by the roots. The author experimented on the point, growing bean seeds in the dark in nutritive solutions, both with and without nitrogen compounds.

As in every case there was a loss of nitrogen, it could not be due to reduction of nitrates, and he attributed it to the loss of nitrogen consequent on the decay of those parts of the seed not made use of by the germinating plant.

Next, treating of the gain of nitrogen, he combats Hellriegel's view, that the root nodules of the Leguminoseæ are concerned in rendering free nitrogen available to the plant. His own experiments lead him to the conclusion that the land gains in combined nitrogen in some way besides that caused by lightning discharges, which at present is the only one undisputed. He found that the presence of vegetation raised the amount of this gain, that this could not be accounted for by the ammonia of the air, and that it must be derived from the free nitrogen of the air. The gain rises with increased plant development, and both the kind of soil and species of plant have an influence. Lupines are very effective as compared with non-leguminous plants; but the difference in the powers of increasing the combined nitrogen is one of degree, not one of kind; hence it cannot be ascribed to the nodules. Further, nodules did not occur in lupines grown in sterilized soil, yet the plants developed better than in a parallel experiment with unsterilized soil, where the plants had nodules, and besides the nodules the legumes have no other organs to supply nitrogen which other plants do not also possess.

The next question is, how soil unoccupied by a crop gains in combined nitrogen. This gain takes the form chiefly or entirely of organic nitrogen compounds, thus agreeing with Berthelot's experiments, and is explained by the growth in the soil of the cryptogamic plants, algæ containing chlorophyll and allied forms which the author discovered there.

He next discusses the question whether these plants avail themselves of free nitrogen or of nitrogen oxidized in the soil by an inorganic process. He asserts that, under the influence of calcium or magnesium carbonates, free nitrogen can be oxidized to nitric acid, the action being distinct at 100°, still apparent at 45°-50°, and no longer apparent at 15°-22°, but thinks that in the German climate this action can only very rarely occur.

He concludes that it is not an inorganic process that makes the free nitrogen available, but that the combined nitrogen is due to a development of plant cells containing albuminoids, which is not to be connected with any process occuring in the soil. This power of assimilating free nitrogen is very different for different plants; the result is smallest in fallow land, where only the lower plant forms are at work; it is larger with higher plant forms, and among these the lupines and probably other Leguminoseæ produce the greatest result.

*Ab.: Jour. chem. soc., January, '89, pp. 71-72.*

# NOTES ON MILK AND BUTTER.

## I. PRESERVATION OF MILK SAMPLES.

(By H. DROOP RICHMOND: *The Analyst*, Jan., 1889.)

The process of preserving milk for analysis, by addition of alcohol as proposed by Allen, is objected to on account of the large amount of preservative necessary to be added. Bisulfide of carbon, ether, dichlorphenol, chloroform, terpenes and hydrofluoric acid were all tried; chloroform was least reliable, and hydrofluoric acid was wholly satisfactory; 0.5 per cent. of the acid or one drop to 10 c.c. of milk proved to be sufficient. The effect is to coagulate the milk, but a vigorous shake brings it again to a condition admitting of correct sampling.

Analyses are given in which total solids and fat were determined in the original sample and again in the preserved sample after periods ranging from 32 to 347 days. The average of 12 samples thus tested, gave 0.02 per cent. less total solids and 0.04 less fat in the preserved milk than in the original samples. Another set of 10 samples, to which the hydrofluoric acid was added, after three days, gave an average of 0.165 per cent. less total solids than the original, after standing 32 days. In this case decomposition had begun before the addition of a preservative. In a third test, a sample of milk was preserved fresh; a portion of the same was allowed to stand three days, and then preserved; after a fortnight the fresh preserved milk gave 0.08 per cent. more solids than the original natural sample: the sample preserved after three days gave 0.37 per cent. less solids.

The author regards this reagent as a perfect preservative when added to fresh milk: if decomposition has already commenced it is of little use.

## II. THE WERNER-SCHMID METHOD OF DETERMINING FAT IN MILK AND CREAM.

(By WERNER SCHMID: *Zeitschrift f. Anal. Chem.*, 1888, p. 464.)

Five cubic centimeters of cream or 10 c.c. of milk are placed in a test tube of 50 c.c. capacity, graduated to 10 c.c. Ten cubic centimeters of concentrated h. cl. are added and the mixture boiled, with agitation, until it becomes dark brown. Cool and add 30 c.c. of ether; shake, allow the ether solution to separate and measure the same. Withdraw by means of a pipette, an aliquot part (10 c.c.) Evaporate on water bath, eventually in an air bath at 100° and weigh. When rightly conducted, the ether separates from the watery solution absolutely clear. The results are accurate, varying within 1-10 per cent, from ordinary methods. With proper arrangements the whole process requires not more than one-half hour.

(By A. W. STOKES: *The analyst*, Feb., 1889.)

The author sought analytical data with regard to the accuracy of the above method and reports some 20 analyses in which the methods of Wanklyn, Adams and Schmid were compared on samples of whole, skimmed, stale and condensed milks, as well as cream. The results were in every case satisfactory, agreeing very closely with those obtained by the Adam's method, both being somewhat higher than by the Wanklyn method.

The acid acts to destroy casein and milk sugar almost entirely, setting free the fat. The ether does not extract all the fat since traces are always present in the acid solution. The ether solution is always acid. A slight contraction of volume follows the addition of the ether. Results were the same whether the mixed fluids were shaken for a longer or shorter period, and whether allowed to stand five minutes or 2½ days. The method seems to possess the advantages of accuracy, speed, simplicity and cheapness.

W. E. S.

## COMPARATIVE EXPERIMENTS WITH PHOSPHATES.

(By L. RAULIN: *Comp. rend.*, 1888.)

The author gives the results of experiments conducted at the Rhone agricultural experiment station, on a soil very rich in humus and calcareous matter, in noting the action of different phosphates upon wheat and maize. The experiments ran through 1887 and 1888. In 1887, the tests were with maize, and it was found that with 50 kilograms of phosphoric acid per hectare the fossil phosphates, coprolites, and phosphorites and phosphate slag were much less active than the industrial phosphates containing soluble phosphoric acid, such as the superphosphates and precipitated phosphate.

In 1888 wheat was employed instead of maize, on the same plats, and the same conditions followed out, excepting that 40 kilograms of phosphoric acid were used. The following table gives the result:

| No. Plat. | Kind of phosphate. | Phosphoric acid. | Excess of crop of maize, in 1887 over the crop without phos. acid. | | Excess of crop of wheat in 1888 upon plats without phos. acid. | |
|---|---|---|---|---|---|---|
| | | | Straw. | Grain. | Straw. | Grain. |
| 1. | Superphosphate in 1887.... | 40 kg. | 1750 kg. | 2300 kg. | ............ | |
| | " 1888.... | 40 " | " " | " " | 1580 kg. | 730 kg. |
| 2 | Coprolites in 1887.... | 200 " | 3400 " | 1700 " | " " | " " |
| | " 1888.... | 40 " | " " | " " | 2010 " | 1580 " |
| 3 | " 1887.... | 40 " | 1820 " | 1000 " | " " | " " |
| | " 1888.... | 40 " | " " | " " | 1340 " | 510 " |
| 4 | Phosphorites in 1887. .. | 200 " | 2300 " | 1400 " | " " | " " |
| | " 1888.... | 40 " | " " | " " | 1180 " | 680 " |
| 5 | Phosphate preci. in 1887.... | 40 " | 3240 " | 3640 " | " " | " " |
| | Poudre d'os in 1888.... | 200 " | " " | " " | 830 " | 660 " |
| 6 | Creusot slag in 1887.... | 200 " | 170 " | 970 " | " " | " " |
| | Slag in 1888.... | 40 " | " " | " " | 780 " | 560 " |

The author concludes from the experiments of these two years, that, phosphatic manures, containing insoluble phosphoric acid, such as the fossil phosphates, may be used, as the superphosphates and the industrial phosphates, with the condition that the first year an application equal to five or six times the usual quantity, be used.

*Ab: Le Progrès agricole et viticole, vi, p. 138.*

## SUGAR CONTENTS OF THE HORSE'S STOMACH.

(By **Ellenberger** and **Hofmeister**: *Pflüger's Archiv*, xli, pp. 484–89.)

Seegen has commented on the small quantities of sugar found in the stomach and intestines, and considers that this may be explained by its rapid absorption immediately it is formed.

The authors state that although a similar state of things may occur with peptone formed from albuminous food, it is certainly not the case in horses and pigs fed on starchy food. The quantity of sugar in the alimentary tract of these animals varies, but they have found from one to 3.5 per cent. of sugar in the stomach of the horse, and from 0.6 to 0.8 in the stomach of the pig.

The conditions on which the varying amount of sugar depends are:—(1) Length of time after meals: the highest amount is present one to one and a half hour after a meal; (2) abundance or otherwise of hydrochloric acid in the gastric juice, which stops the conversion of starch into sugar; (3) condition of the starch in the food, whether cooked or uncooked, corn or potatoes, etc.; (4) another condition which must not be overlooked is the difference of reaction in different parts of the stomach, and if the contents are not properly mixed, more sugar will be found in one part than another. Seegen appears to have killed his animals too late, 3½–13 hours after a meal.

*Ab.: Jour. chem. soc., Feb., 1889, p. 176.*

## COMPOSITION AND NUTRITIVE VALUE OF OATS.

(By M. MARCKER: *Bied. Centr.*, 1889, pp. 697–704.)

From a number of analyses and experiments on several varieties of oats, the details of which are given, the following conclusions are drawn:—The heavier yielding sort is poorer in albuminoids than the lighter yielding; there is no definite ratio between the percentages of fat and albuminoids; that sort which comes quickest to maturity is richest in albminoids; the grain poorest in albuminoids has the lowest bushel-weight, and the largest individual grains are also the poorest in nitrogen; the coefficient of digestion does not seem to be influenced by the composition. Those grains which are smallest in size and richest in nitrogen have most hull, and generally this huli is poorer in albuminoids than that of other grains. The thickness of the skin surrounding the seed, measured immediately above the embryo, is not invariable—in one year it may be thickest in the large grains, while in other years it is thinnest. A table of germinative power, with total yield of nutrients per acre is given.

*Ab.: Jour. chem. soc., Feb., 1888, p. 184.*

## DECOMPOSITION OF ALBUMEN IN THE ABSENCE OF FREE OXYGEN.

(By W. PALLADIN: *Ber. Deutsch Bot. Gesell.*, 1888, pp. 205–212.)

The author made a series of experiments on *Triticum vulgare* and *Vicia faba*, and drew the following conclusions: (1) If green plants containing non-nitrogenous substances are placed in an atmosphere destitute of oxygen for not longer than 20 hours, no loss of albumen takes place. (2) If, however, the plants have been previously deprived of their non-nitrogenous substance, they will, in these circumstances, lose a portion of their albumen in the first 20 hours. (3) The decomposition of albumen can maintain the life of a plant for a time in an atmosphere containing no oxygen; (4) this decomposition is independent of the atmospheric oxygen; (5) the decomposition of albumen which takes place in a non-oxygenous atmosphere during the fourth and fifth days is a phenomenon which continues after the death of the plant; (6) active decomposition of albumen takes place in the ordinary atmosphere in the dark, beginning even during the first 24 hours.

*Ab.: Jour. roy. micr. soc., 1889, pp. 92–93.*

## DISEASES OF THE VINE.

(By P. VIALA and L. RAVAZ: *Rev. Mycol.*, x (1888), pp. 193–9.)

The disease known as mélanose, which is caused by the parasite *Septoria ampelina*, B. & C., originally came from America. Mélanose appears only to attack the leaves of the vine, and has not as yet been observed either on the branches or on the fruit. Small circular brown spots, which are equally apparent on both surfaces of the leaf, are the first indications of this disease ; these grow rapidly and change in color to a deep brown or sometimes even black. The mycele of this fungus, which grows in the tissue of the leaf, is wavy, thin and hyaline, and the pycnids are ovoid and nearly entirely buried in the plaisade-tissue of the leaf. The cells of the envelope of the pycnid are small, irregular, and with a rather thick membrane; the innermost layer gives rise to the spores.

*Ab.: Jour. roy. micr. soc., 1889, pp. 100–101.*

### STRUCTURE OF WHITE ROT.

(By G. FOEX and L. RAVAZ: *Rev. Mycol.*, 1888, pp. 201–3)

The authors state that a transverse section of the portion of a plant attacked by "white rot" reveals the presence of the mycele of *Coniothyrium diplodiella.* The filaments which compose it have uniform structure. The spores arise on the stigmata, to the summit of which they remain fixed until they have finished growing, when they detach themselves from their support. They are generally ovoid in form; and if they are placed in a drop of water they germinate in a few hours at a temperature of 18° to 20°. As for the remedies to apply for "white rot," it has been found that the salts of copper are the most efficacious.

*Ab.: Jour. roy. micr. soc., 1889, p. 100.*

## EXPERIMENT STATION ABSTRACTS.

### ANIMAL NUTRITION.

### RECORD OF TWELVE COWS.

(*Mass. state experiment station, Bulletin 32.*)

The figures quoted relate to twelve cows used in milk production experiments at the Mass. state station, over periods of observation ranging from 261 to 599 days.

The daily rations consisted of from 18 to 26 or more pounds of meadow hay or its equivalent in part or in the whole of dry vegetable matter of the above mentioned bulky fodder articles, and from six and one-half to nine and three-fourth pounds of grain feed, usually composed of an equal weight of corn meal or corn and cob meal and wheat bran, with or without gluten meal (3¼ lbs.)

Five cows were Ayrshire, two Jerseys, two Shorthorns, one Devon, one Dutch, one native. The animals varied in age from five to ten years, and had dropped from two to ten calves. The cows were secured a very few days after calving. The least number of days any one of these cows were milked were 261, the

Devon, and the greatest, 599, a Jersey. The smallest average yield of milk per day, in quarts, was 7.7 from a Shorthorn, and the greatest average 12.4 qts. from each of three cows, viz.: Ayrshire, Devon and Shorthorn.

The total cost of the feed eaten depended upon the length of the feeding period and the material fed, the smallest expense being $56.04, for Mollie, an Ayrshire, milked 307 days, while the cost of May's feed, a Jersey, milked 599 days, was $140.39.

The following table, which shows the valuation of the essential fertilizing constituents contained in the various articles of fodder used, is interesting and valuable. Nitrogen is classed as worth 16½ c. per. lb., phosphoric acid 6 cents and potassium oxide 4¼c.

| | Nitrogen. | Phosphoric acid. | Potash. | Valuation per ton. |
|---|---|---|---|---|
| Corn meal | 1.86 | 0.77 | 0.45 | $7.44 |
| Corn and cob meal | 1.46 | 0.603 | 0.441 | 5.91 |
| Wheat bran | 2.82 | 3.05 | 1.49 | 14.24 |
| Rye middlings | 1.84 | 1.26 | 0.81 | 8.27 |
| Gluten meal | 5.22 | 0.40 | 0.05 | 17.75 |
| Hay | 1.25 | 0.464 | 2.085 | 6.46 |
| Rowen | 1.93 | 0.364 | 2.86 | 9.24 |
| Corn fodder (dry) | 1.37 | 0.368 | 0.355 | 5.26 |
| Corn stover (dry) | 0.78 | 0.09 | 0.599 | 3.19 |
| Corn ensilage | 0.36 | 0.14 | 0.33 | 1.64 |
| Millet (dry) | 1.106 | 0.38 | 2.49 | 6.23 |
| Lucern and vetch (dry) | 2.02 | 0.70 | 2.273 | 9.44 |
| Lucern and clover (dry) | 2.06 | 0.623 | 1.805 | 9.08 |
| Oats (dry) | 1.47 | 0.51 | 2.41 | 7.51 |
| Vetch and oats (green) | 0.33 | 0.155 | 0.68 | 1.85 |
| Vetch (green) | 0.23 | 0.09 | 0.79 | 1.54 |
| Seradella | 0.411 | 0.14 | 0.423 | 1.89 |
| Cow pea (green) | 0.561 | 0.098 | 0.306 | 2.23 |
| Barley and horse beans (green) | 0.50 | 0.20 | 0.40 | 2.23 |
| Potatoes | 0.476 | 0.18 | 0.56 | 2.18 |
| Carrots | 0.14 | 0.10 | 0.54 | 1.04 |
| Sugar beets | 0.29 | 0.03 | 0.18 | 1.15 |

The following figures are all averages: Cost of cow $62.29; selling price at end of experiment $28.80; total cost feed per day 21.72 cts.; product per day for entire period, per head, 11.14 qts.; net cost of feed per day, 12.94 cts.; value received above net cost of feed and cow per day, 12.12 cts.; value received in form of manure, per day, 8.78 cts.; value received in cash daily, 3.34 cts.

It is shown that the total value received above net cost of feed and of cow, consists in every instance in a controlling degree in the manure obtainable.

## SEED TESTING EXPERIMENTS.

### EXPERIMENTS IN GERMINATION AND GROWTH OF DAMAGED WHEAT AND BARLEY.

(*Minnesota agricultural experiment station. Bulletin No. 6, pp. 28.*)

These experiments were conducted in a green-house, by Prof. S. B. Green. The author states that the difference between rusted and frosted wheat is not clear, even to those who are the best judges of wheat. The wheat was sown in prairie soil, in a center bench running north and south. The seed was planted one-half inch deep in good prairie soil. The night temperature of the house was 40 degrees and the day temperature, about 65. In each case the first leaf appeared above the soil in about three days after planting.

In section one, five lots of wheat and one of barley, said to be frosted, were planted, 300 from each sample. The samples germinated as follows: (1) 85 per cent.; (2) 67; (3) 74; (4) barley, 100; (5) 72; (6) 52. In every case a vigorous, healthy growth was made by the plant. The quality of seed in this section was quite regular.

In section two the quality of seed was very variable. Each sample was tested in water for lightness, and the heavy "sunk" seed kept separate from the light. The following concise table gives the principal facts concerning each of the lots tested in this section. The plants in every case were healthy, vegetated Jan. 8, and varied in hight Feb. 4, from 9 to 12 inches.

| No. of sample. | Inspectors grade of sample. | Wt. per bu. | Per cent. of sunk seed in sample. | Per cent. of healthy growing plants from sunk seed. | Per ct. of seed from whole samples forming healthy plants. |
|---|---|---|---|---|---|
| 7 | No. 2 Northern, 2 lbs. off... | 55 | 96 | 96 | 92 |
| 8 | " 1 " 2½ " "... | 57 | 96 | 84 | 84 |
| 9 | " 3 " 1 " "... | 52 | 76 | 86 | 86 |
| 10 | " " " 1 " ".... | 58 | 96 | 92 | 92 |
| 11 | " 1 hard, 2 " "... | 59 | 98 | 92 | 92 |
| 12 | Rejected.............................. | 56 | 96½ | 92 | 92 |
| 13 | No. 3 Northern 2 lbs. off... | 56 | 97½ | 78 | 78 |
| 14 | " " " "... | 57 | 97 | 92 | 92 |
| 15 | No grade........................... | 44 | 72 | 68 | 68 |
| 16 | No. 1 Northern, 1½ lbs. off.. | 57 | 97½ | 88 | 88 |
| 17 | " " 2 " ".. | 57 | 96½ | 90 | 90 |
| 18 | " 3 " 1½ " ".. | 56 | 96½ | 88 | 88 |
| 19 | " 3 " .................. | 54 | 94½ | 82 | 82 |
| 20 | Rejected.............................. | 54 | 93 | 86 | 86 |
| 21 | Chicken feed......................... | 39 | 35 | 48 | 43 |
| 22 | " " ..................... | 40 | 39 | 48 | 48 |
| 23 | " " ..................... | 43 | 62½ | 60 | 42 |
| 24 | " " ..................... | 41 | 55 | 60 | 46 |
| 25 | " " ..................... | 39 | 68½ | 67 | 42 |
| 26 | " " ..................... | 40 | 67½ | 64 | 56 |
| 27 | " " ..................... | 46 | 72½ | 66 | 60 |
| 28 | No grade............................ | 47 | 67½ | 76 | 63 |
| 29 | " " ........................... | 51 | 91 | 86 | 79 |
| 30 | " " ........................... | 43 | 83½ | 74 | 69 |
| 31 | Chicken feed......................... | 45 | 66 | 76 | 50 |
| 32 | Rejected............................. | 53 | 66 | 66 | 66 |
| 33 | No. 5 Barley......................... | 34 | 93 | 80 | 80 |
|  | Prize wheat.......................... | 59 | 100 | 78 | 78 |

The following table showing the per cent. of growth of seeds which were so light they floated on the water, is of interest:

| No. sample. | Per cent. light wheat. | Per cent. light wheat forming good plants. | Per cent. heavy wheat forming good plants. | Total per cent. good plants from whole samples. |
|---|---|---|---|---|
| 21 | 65 | 12 | 48 | 34 |
| 22 | 61 | 18 | 48 | 48 |
| 23 | 37¾ | 18 | 60 | 42 |
| 24 | 45 | 30 | 60 | 46 |
| 25 | 31½ | 16 | 67 | 42 |
| 26 | 32½ | 50 | 64 | 56 |
| 27 | 27½ | 23 | 66 | 60 |
| 28 | 32½ | 18 | 76 | 63 |
| 31 | 34 | 16 | 76 | 50 |

Although as high as 50 per cent. of some of the wheat which was soft as well as shrunken has germinated, yet its apparent vitality is not so great as the hard shrunken, and in every case of the latter, there was a good per cent. of germination, and a strong growth. Wheat under 40 lbs. per bushel had low germinative powers.

### THE GERMINATION OF FROSTED GRAIN.

(*Dakota agricultural experiment station. Bulletin No. 10, pp. 8.*)

Eighteen samples of grain were tested, by different methods, *i.e.*, in soil, between carpet paper, moistened, under various conditions. One hundred seeds of each sample were tested. The germinative capacity of plump, slightly shrivelled and much shrivelled seeds was compared, and it was shown that seeds do not germinate according to plumpness. The percentage of germination varied from 20 to 99, however but four samples geminated less than 50 per cent., and in most cases from 70 per cent. upward.

## PLAT EXPERIMENTS.

### FIELD EXPERIMENTS WITH CORN.

(*Kentucky agricultural experiment station. Bulletin No. 17, pp. 21.*)

Tests were made of the effect of combinations of various plants foods. The plats, one-tenth acre, were high, sloping from the center, and the soil derived from the lower Silurian limestone, with a retentive clay sub-soil. The season was very favorable. The corn was a white dent, grown two plants per hill. The fertilizers were applied broadcast. The plats were manured as follows: one, nothing; two, acid phosphate, 30 lbs., sulfate potash, 10 lbs., sulfate ammonia, 15 lbs.; three, acid phosphate, 30 lbs., sulfate potash, 10 lbs.; four, acid phosphate, 30 lbs., sulfate ammonia, 15 lbs.; five, sulphate potash, 10 lbs., sulfate ammonia, 15 lbs.; six, no fertilizer; 7a, acid phosphate, 15 lbs., sulfate potash, 5 lbs., sulfate ammonia 7½ lbs., sulfate potash in hills, 3 lbs.; 7b, was treated with three lbs. sulfate potash in hills.

In plats where potash was one of the ingredients, there was a marked increase in yield of corn and fodder. In plat four there was no increase over an average of one and six. Nitrogen produced no increased yield, as combinations of potash and phosphoric acid gave as good results as where nitrogen was added to them. Plat 7a, which received the same fertilizer as plat two, excepting for sulfate of potash in the hill gave 16.6 more bushels of corn per acre. This experiment is graphically illustrated with an engraving prepared from a photograph, in which the comparative production of the plats is shown.

Ten other plats were used, two of which had no fertilizer, and the other eight in duplicate, each receiving 160 lbs. sulfate potash, 60 lbs. sulfate ammonia and 100 lbs. dried blood. In the case of these fertilized plats, the yields with one exception, were fairly constant, and indicated the effect of potash.

An application of copperas was made to two plats in another experiment, but without especially beneficial results.

The value of tobacco stems as a fertilizer was clearly demonstrated, for in comparing two plats, one of which received this as a fertilizer, while the other received nothing, the former produced 80.1 bu. corn, per acre, against the other's 47.6 bu.

An attempt was made to determine if the application of fertilizers have any relation to the amount of phosphoric acid, nitrogen and potash taken up by the crop, and analyses were made of fodder, kernel and cob. In no instance was as much potash taken up in the crop as was applied in the fertilizer.

## FERTILIZER EXPERIMENTS ON CORN.

(*Ohio agricultural experiment station. Bull. No. 7, pp. 91-110.*)

Various plats were grown to Indian corn, and fertilized separately or in combination, with dissolved bone black, muriate potash, nitrate soda, sulfate ammonia, rock phosphate, slag phosphate, barnyard manure, linseed oil meal, and others left unfertilized. The soil on which the plats are located is a clay loam with gravel subsoil. The results were unsatisfactory, and indicated that the land did not need fertilizers, the unfertilized making a good showing beside the others. The shrinkage and amount of corn compared with the amount of cob in each 100 lbs. did not indicate any effect from fertilizers.

On a slaty soil, at a sub-station, 14 plats were tested with fertilizers on corn. On these plats, potash alone, or with phosphoric acid, gave no special benefit, while nitrate of soda alone, or in combination with potash and phosphoric acid, gave good results.

The same results occurred in fertilizer tests on lake sand and field soil, in boxes, potash alone giving poor results, but with nitrogen and phosphoric acid making itself specially felt, while nitrate of soda made the best showing of all.

## POTATO EXPERIMENTS.

(*Kentucky agricultural experiment station. Bull. No. 16, pp. 22.*)

The soil on which these experiments were conducted is derived from gray and blue limestones of the upper portion of the Trenton group of the lower Silurian. It is a clay, with a light retentive clay sub-soil.

### METHODS OF CUTTING AND PLANTING.

This soil was the poorest on the farm. Six plats were planted as follows: (1) average run of seed from barrel, cut to two eyes; (2) large, whole potatoes; (3) small, whole potatoes; (4) two eye pieces from large tuber; (5) ditto from small; (6) average tubers cut to two eyes, 24 inches apart, all the others being 14 inches apart. Large whole potatoes 15 bushels more than the next best, small whole. The poorest crop was from plat six. While it is agreed that the increase in crop occurs in large seed over small, it did not pay to plant large whole tubers at the rate of 47 bu. per acre, as the season was unfavorable to the test. However, the director states that "when the season is favorable and the soil rich, the evidence from many experiments tends to show that the value of the increased yield produced by planting large sized potatoes more than compensates for the increased outlay for seed."

### TEST OF FERTILIZERS.

Early rose potato was the variety used, cut to two eyes, planted 14 inches apart in the row, the latter being three feet apart. The following fertilizers were used: acid phosphate, sulfate of potash, muriate of potash, sulfate of ammonia, singly or combined in various proportions, there being 11 plats, two of which were unfertilized, and one received 80 loads per acre of stable manure.

Sulfate of potash, 200 lbs. per acre, gave the highest yield, 129.7 bu. per acre, and no very material gain (3.5 bu.) was made by adding acid phosphate. The yield was not increased by the application of ammonia sulfate. It was concluded that potash is what is needed on the station soil. It is worthy of note that stable manure gave a comparatively high yield, 122.4 bu.

A test was made of the effect of fertilizers on the quality of the tubers, but in every case the potatoes were of inferior quality, the greatest per cent. of dry matter coming from the acid phosphate and sulfate of potash, 20.3 parts in 100.

## DISEASES OF PLANTS.

### ROOT ROT OF COTTON, OR "COTTON BLIGHT."

(*Texas agricultural experiment station, Bull. No. 4, pp. 19.*)

Prof. L. H. Pammel offers this as a preliminary report upon root rot of cotton. This disease is especially prevalent in low black soils, and it is generally thought is favored by excessive soil moisture. The author notes the various portions of the state in which it is especially prevalent.

Various theories are offered as the cause of this disease. Chemical analysis at the station of soil from "dead spots" and from that where cotton does not thus die showed little or no difference in character. Some have thought sulfuric acid in the soil the cause. Experiments with copperas on cotton, did not kill the plant. Careful investigation does not indicate the disease especially prevalent in alkali soil or lime soil. The author is further convinced that insects do not cause the trouble. Nematodes and mites were never found excepting when the root was in a decayed condition.

There is no doubt but what the indications are that this is a fungus disease. The first indication of the malady, is the sudden wilting of plants here and there in the field late in June, which become dry in from 12 to 24 hours. It is probable, however that the disease makes its appearance very much earlier, attacking young plants. The disease spreads, the plants die suddenly, and in July or August "dead spots" of considerable size may occur in the field. Certain plants probably do not become infected.

A root of the wilted plant examined immediately after a rain, or from moist soil, will show a mass of sterile mycelium, and in numerous places small protuberances. This mycelium has been identified as *Ozonium auricomun*, Lk. Everywhere this fungus occurs associated with the disease. The protuberances penetrate through the bark into the wood tissue. This same fungus is found in abundance on the sweet potato. Sudden wilting of the plant is one of the disease characteristics, and this is caused by the elaborated material in the leaves being checked when the malady is in progress, and thus cannot supply the roots with nourishing material to develop new roots and root hairs.

The disease is infectious, and extends year after year unless rotation of crops is practiced. The best method to prevent the disease is to burn the diseased stalks ; there is good evidence also that fertilizers prevent it.

## SOIL FERTILITY.

### ROOTS OF PLANTS AS MANURE.

(*Storr's school agricultural experiment station. Bulletin No. 3, pp. 8.*)

These experiments were undertaken to determinate the relative amount of manure existing in the roots of certain plants.

The stubble and roots were separated and analyzed, the samples being as nearly as possible, average specimens. Blocks of earth two feet square were first made available, by trimming the soil away from about them, and then these blocks carefully cut into smaller parcels, about six inches in depth, placed in boxes, and the roots sorted from the soil. The soil of the farm to a depth of seven inches is a light loam, the sub-soil yellow and compact.

Cow peas, stubble and roots, from a field which yielded 15,840 lbs green fodder per acre, gave 558 lbs. of roots per acre. From the same field, in a different location, a total weight of stubble and roots of 1207.8 lbs. per acre occurred to a depth of 42 inches. Timothy and red top stubble, with roots from the first six inches of soil, after drying in the laboratory had a weight equivalent to 7944 lbs. per acre. Between six and 36 inches 678.2 lbs. of roots occurred. With buckwheat stubble and roots, down to 12 inches occurred a weight of 523.6 lbs., the third six inches being nearly free of roots.

The following table giving the amount of roots and stubble and valuable ingredients left in one acre, with valuable ingredients in manures, is worthy of being recorded here. It embraces observations made at Storr's, Middletown, Conn., by Dr. Voelcker in England and Weiske in Germany. The figures are pounds.

| Kind of plant and part analyzed. | Roots and stubble. Water free. | Nitrogen. | Phos. acid. | Potash. |
|---|---|---|---|---|
| *Storr's School.* | | | | |
| Cow peas. Stubble and roots to 6 in. deep | 711 | 10.0 | 2.7 | 5.3 |
| " " " " " " 3½ feet | 1095 | 14.5 | 2.8 | 6.4 |
| Timothy and red top. Stubble and roots to 6 in. deep | 7606 | 83.7 | 23.8 | 53.5 |
| Timothy and red top, 6 in. to 3 feet deep | 617 | 6.4 | 1.4 | 2.3 |
| " " " " Total stubble, etc. to 3 ft. | 8223 | 90.1 | 25.2 | 55.8 |
| Buckwheat. Stubble and roots to 1 foot | 483 | 4.4 | 1.3 | 3.8 |
| *Middletown, Conn.* (*W. O. Atwater*,) | | | | |
| Timothy roots | 2240 | 31.1 | 7.0 | 8.4 |
| Wheat " | 658 | 6.4 | 1.5 | 2.6 |
| Clover " | 1335 | 35.5 | 10.0 | 15.0 |
| *Dr. Voelcker, England.* | | | | |
| Good clover roots. First year | 4155 | 100.0 | | |
| Bad " " " " | 1550 | 31.0 | | |
| Thin " " Second " | 7026 | 66.0 | 29.5 | |
| Good " " " " | 6503 | 65.0 | 27.0 | |
| Clover roots. First year. Mown twice | 1493 | 24.5 | | |
| " " " " " once | 3622 | 51.5 | | |
| *Dr. Weiske, Germany.* | Air dry. | | | |
| Rye. Roots and stubble | 3400 | 62.0 | 24.0 | 30.0 |
| Barley " " " | 1515 | 22.0 | 11.0 | 9.0 |
| Oats " " " | 2200 | 25.0 | 28.0 | 24.0 |
| Wheat " " " | 2240 | 22.0 | 11.0 | 17.0 |
| Red clover " " | 6580 | 180.0 | 71.0 | 77.0 |
| Buckwheat " " | 1630 | 45.0 | 10.0 | 9.0 |
| Peas " " | 2400 | 53.0 | 14.0 | 11.0 |
| Lupine. " " | 2800 | 58.0 | 13.0 | 16.0 |

# AGRICULTURAL SCIENCE NEWS.

A new agricultural college has been located in Valley City, Barnes county, North Dakota, by the last legislature.

Early in March a school for giving practical instruction in grafting, was established for a few weeks at Capezzine. Italy.

A. S. Welch, for many years president of, or otherwise connected with the Iowa agricultural college, died at Pasadena, California, on March 15.

Pres. Willets of the Michigan agricultural college has been made assistant secretary of the United States department of agriculture.

The annual report of the Iowa agricultural college for 1888 shows an enrollment of 265 students and 27 professors and instructors

The Alabama legislature at its last session appropriated $60,000 to rebuild the building destroyed by fire at the agricultural and mechanical college at Auburn.

A dairy school, the first of its kind in Scotland, was opened at Kilmarnock on March 11. The school is arranged for cheese and butter making, and is well equipped with teachers.

M. Jean Risler, instructor in agricultural chemistry in the national agricultural institute of France, died about March 1 in Paris, at the age of 33 years, his death being caused by a phosphorus burn in the laboratory.

Prof. A. J. Cook of the Michigan agricultural college has published a small 31 page pamphlet entitled "The silo and silage," that strongly advocates the use of ensilage on the farm, and contains many useful points.

The March bulletin of the royal gardens, Kew, contains matter on the following subjects: Fibre industry at the Bahamas. Hardy species of eucalyptus. Yam bean. West African rubbers. Phylloxera in Asia Minor. Botanical station at Lagos. Chiga bread.

Dr. Carl Zeiss of Jena, Germany, the famous optician and manufacturer of microscopes, is dead at the age of 73 years. Dr. Zeiss during his lifetime rendered most important service to the upbuilding of microscopical knowledge, and his objectives were famous among scientists the world over.

T. Dietrich compares (*Landw. Versuch Stat.*, 1888, pp. 309–318) the percentage of albuminoids in wheat, and shows that the mean of 937 analyses of English, Russian, etc., wheats. gives 13.90 per cent. of crude albuminoids in the dry substance, while the Indian wheats contain only 12.66 per cent. as a mean.

The university of Tennessee and state agricultural and mechanical college has never received a cent from the state treasury. During the state legislative session recently adjourned, a bill was entered calling for an appropriation of $7,800 to pay for certain expenditures made in the way of repairs on old buildings, and erecting one new one, but was killed in the Senate, and a vote to reconsider lost.

*Insect life* for February, 1889, contains matter on the life history and habits of the red bug or cotton stainer (*Dysdercus suturellus*, H. Schf.) and Mr. L. O. Howard describes a parasite of this insect, a new species. *Hadronotus rugosus*, Howard. This same number also has an article on insecticide apparatus by C. V. Riley, and S. A. Forbes gives evidence tending to locate the chinch bug in the Mississippi valley as early as 1823.

Dr. F. Cavara enumerates (*Bot. Centr.*, xxxvi, p. 145) the following new species of fungus as attacking the vine: *Physalospora baccæ*, *Glœosporium physalospora*, *Pestalozzia viticola*, *Napicladium pusillum*, *Alternaria vitis* and *Tubercularia acinorum*. The author gives the following diagnosis of the new genus Briosia: Stroma verticale, cylindraceum, stipitatum, hyphis fasciculatis compositum, apice capitulum compactum efformans; conidia globosa, tipice catenulata, fasca, acrogena.

In *Psyche* (Oct. '88) Prof. S. A. Forbes notes two diseases of *Blissus leucopterus*, efficient in suppressing an outbreak of this species in 1882, and a third, due to a microbe, *Micrococcus insectorum*, Burrill, which is principally developed in the alimentary canal, and especially in the cæcal appendages, which are often literally crammed with it, from end to end. The disease somewhat resembles that known as *schlaffsucht* or *flacherie* in silkworm literature. Its germ is freely cultivable in beef broth and solid gelatine media. This disease, with the other two, will probably largely aid in suppressing the ravages of the chinch bug in Illinois.

Dr. J. H. Wakker discusses (*Arch. Néerland*, xxii (1888), pp. 1–71) the malady caused by *Bacterium Hyacinthi*. The bacteria which may be regarded as the cause of this disease are more or less cylindrical and colorless, and may be found by myriads in the yellow mucilage of the bulbs that are attacked. The spores of *B. Hyacinthi* are slightly longer than they are broad, and are bluish in color. Another disease of hyacinths and allied plants, caused by *Peziza bulborum*, is also described. The spores of this fungus are ovoid and colorless, and are contained in asci; they show two bright bluish spots, each situated at the same distance from the extremities.

The Massachusetts agricultural college is in a most prosperous condition. At no time, with one exception, has there been a larger attendance of students, the total for the year, 1888–89 being 149, the freshman class being 48. The library contains 8,285 volumes, and during the year the students drew out on an average 14 books each. Of the graduates of the college, 46 are farmers, six fruit growers and market gardeners, eight florists and landscape gardeners, four planters, nine poultry and stock raisers, seven veterinarians, two editors of agricultural papers, four fertilizer manufacturers, nine chemists to fertilizer companies and 28 engaged in agricultural colleges or experiment stations. There are 150 other graduates engaged in various occupations. The college farm is being much improved, and has 46 head of cattle, consisting of Jerseys, Guernseys, Short-horns, Holstein-Friesians and Aryshires; 31 pigs and twenty-three Southdown sheep. In 1888, 212 tons of hay were cut from a little over 80 acres of land.

An interesting account is given in *Nature* (Feb. 21, '89) of the school of forestry at Dehra Doon, India. The school was organized in 1878. The director is W. R. Fisher, B. A., of Cambridge university, assisted by E. E. Fernandez, professor of forestry, and Dr. H. Warth, professor of geology and chemistry. The school has a well equipped museum containing a magnificent collection of accurately named Indian woods; an herbarium; and a chemical and meteorological laboratory. The students are usually selected in the different provinces by the conservators of forests, and are generally young officers. There are two courses of study leading to the ranger's certificate, which qualifies a student to obtain an appointment as "forest ranger" on salary from Rs. 600 to Rs. 3,000 yearly. The ranger's course lasts 21 months, eight being theoretical instruction, the rest practical. The subjects taught are forestry, botany, elements of zoology, chemistry, physics, geology, mathematics, surveying with elementary engineering, such as road making and the construction of forest export works, and forest law. The forester's course lasts 16 months, four in theoretical study, the balance in the field, and elementary forestry and botany, mathematics, surveying, plan-drawing and departmental procedure are taught. The students dress in uniform. A number of important forests are connected with the school.

# EXPERIMENT STATION ITEMS.

Mr. W. S. Devol, botanist and bursar of the Ohio station, was in March elected to the charge of the field work of the Nevada agricultural experiment station, at Reno.

Bulletin four of the Alabama station contains information regarding strawberry, grape and raspberry culture, intended as a response to numerous inquirers who wish instruction, as well as for local experimenters.

The Ohio station sends out addressed cards, about the size of postals, having printed on the opposite side a request for bulletins or reports, as the case may be. It is a very convienient method.

The subject of "composts" is given interesting discussion in bulletin 61 of the North Carolina station, and many practical formulas for making composts are published from farmers.

The first report of the Delaware station is mainly descriptive of the new station building and plan of organization. The frontispiece engraving of the station building, is a wretched piece of engraving.

The Cornell university station has issued its first report. It contains a brief financial statement, and short reports of the various chiefs of departments, with the first four bulletins of the station bound in.

The New York station, at Geneva, has published in pamphlet form an address by Mr. W. W. Wright, one of the board of control, on "the utility of experiment stations," in which he briefly alludes to the past and present work of and future prospects of the Geneva station.

Homer J. Wheeler, a graduate of the class of 1883 at the Mass. agricultural college, and at present a student at the university of Göttingen, Germany, has been chosen to fill the position of chief chemist to the Rhode Island station.

The 18th bulletin from the Wisconsin station is by Dr. S. M. Babcock, and relates "to the constitution of milk, and some of the conditions which effect the separation of cream." In the words of the auther, "in this bulletin the endeavor has been made to present in a brief manner some of the more important facts now known,.concerning the constitution of milk, and to trace the influence of its different constituents upon the separation of cream."

The North Carolina station sends out a circular calling for the coöperation of experiment stations in aid of establishing a common standard of value for vitality and purity of field and garden seeds. The circulars arranged with blanks for filling out, concerning the weight of impurites which should be allowed; per cent. of vitality to be required, greatest permissable age, and maximum, minimum and optimum temperature for sprouting a large list of seed, the names of which are given. The plan is a most excellent one, and should receive the cordial support of the stations of the country.

At the Nebraska station, the plan of work begun, takes up the following subjects: Observations upon soil temperatures, rainfall, soil evaporation, irrigation, native and introduced grasses, clovers, forage plants, cereals and garden crops; chemical examinations of the soils and waters of the state; observations upon temperature, humidity, atmospheric pressure, velocity and direction of wind, and cloudiness; upon the nature, etc., of swine plague, Texas fever, eye disease in cattle, disease of external sexual organs, in cattle, rabies in cattle, a new cattle disease mistaken for anthrax and actineomycosis in cattle; injurious insects; study of native grasses, and injurious fungi. Of the government income, $6,325, is appropriated for the study of animal diseases.

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AGRICULTURAL SCIENCE.

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# THE WINTERING OF RUST IN WINTER WHEAT.

BY H. L. BOLLEY.

It is a well known fact, at least to botanists, that the plant disease commonly known as rust, which attacks and greatly reduces the power of production of many of our most valuable agricultural and horticultural plants, is the result of a parasitic fungal growth. The fungus possesses a very high degree of parasitism, living not only upon its host, but oftimes making itself essentially a part of the same, so that its evil effects are all the greater, in that the diseased plant cannot even die at the point of attack, and thus rid itself of its enemy—but must continue to nourish the same parasitic tissues throughout an entire period of growth.

The life history of most of the species of rust (Uredineæ) may be divided into three periods consequent upon three different stages of development. Each of these growths produce fruit or spores which may germinate to produce the next form in order of development.

The spores formed are designated in order of their development, from spring to autumn, as aecidia, uredo and teleutospores. These different spore formations, according to the nature of the species, may be formed together upon the same host, or may be developed separately upon different host species. Those species which produce the rusting of the cereals and various of the grasses, develop the uredo and teleutospores upon the grasses and sedges, while the aecidia form is always found upon some non-glumaceous plant, generally some of our commonest weeds.

As the teleutospores in these species do not as a rule germinate the same year in which they are formed[1] but rest over winter and upon germination upon the right host in the spring produce the aecidia from which in turn, the uredo form is developed upon the grasses, it has usually been considered that the aecidiospores are necessary to the continued life of these parasites. But it seems very probable that, in order that there may be an outbreak of rust epidemic upon the grasses, it is not necessary that there be a direct infection through the aecidiospores in the spring. It has already been noticed by German authority[1] that the rust mycelium of certain of these species may pass the winter in the tissues of the host uninjured.

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[1] Ploughwright has lately ascertained that, in England under favorable conditions *Pucc-Rubigo-vera*, D. C. may germinate in the fall. In the case observed, it produced an aecidium upon *Anchusa arvensis* in Sept. "British Uredineæ and Ustilagineæ," p. 168.

In order that I might verify the statement and determine whether the same is true of the wheat rust of this country, I have conducted a series of observations regarding the same throughout the present winter. These observations were made upon experimental wheat plats which were seeded at different dates, ranging from the middle of August to late in November, upon a field from which rusted wheat had previously been harvested. The early seedings were attacked by rust in the uredo form almost as soon as up, and continued to rust badly until about the middle of October. At this time the disease essentially ceased to attack new plants, showing that the conditions were not favorable to farther spore germination. The wheat from the late seedings has up to date remained entirely free from the fungus. The rust reached its maximum stage of fruiting during the warm weather of the first two weeks of October, after which new pustules broke through the epidermis very scatteringly. However, new spots were formed until late in November but teleutospores did not appear. When frost came, the weakening influence of the parasite upon the young plants was very noticeable in that the attacked leaves, because of their reduced vitality, were unable to resist the cold and died back from the tips[2]. In many cases the parasite thus brought about its own destruction, for the most badly diseased leaves died to the sheath at the first heavy frost; hence the fungal hyphæ were cut off from the living plant. In these cases close microscopic examination failed to show any fungal filaments in the sheath. In most cases, however, the fungus made good its retreat, as the apical leaf parts perished and at times formed new fruit sori in fresh portions of the leaves.

Bright pustules were seen up to the continued cold weather of February, when the leaves seemed to have died to a point behind the seat of fungus' activity. But in nearly every case microscopic sections of the green basal portions were found to be thoroughly ramified by the living hyphæ.

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[1] Sorauer: "The mycelium of rust, at least that of *Pucc-straminis*, passes the winter uninjured in the parenchyma of the leaves of cereals"—Pflanzenkrankheiten, 2nd ed., vol. ii, p. 216.

[2] Bessey has also found that leaf-cells attacked by the mycelium of *Aecidium Fraxini* have less power to resist cold than the other cells. Proc. am. ass. adv. sci., xxxi, p. 464.

For the general effects of parasitic fungi upon the physiological powers of their host, see article by Seymour in Am. nat., Dec., 1887.

Already, since the warm weather began, the rust is upon the aggressive. On March 25 I found many plants upon which new spots had developed upon green parts of leaves which had been slightly winter killed, consequent upon a previous growth of fungus. One small leaf which had one old pustule upon the dead tip, now possessed nine new ones upon the live portion.

Two different varieties of uredospores were noted. The most abundant form possesses the systematic characteristics of *Puccinia Rubigo-vera*, D. C. Should the appearance of the teleutospores in the spring confirm this supposition, the fact of its power to pass the winter uninjured, may in a certain degree account for the very early development of this species upon the wheat in the spring, and for the scarcity of its ascidium-bearing hosts.

It may be asked, from whence comes this new attack upon the young plants of winter wheat? The nature of the uredospores is an answer. Though they are formed most abundantly in the spring and early summer, they are also developed until late in the autumn upon various grasses and may be wafted by winds to the young wheat. Volunteer growths of wheat and oats upon old stubble fields furnish good hosts upon which the formation of these spores may be continued throughout the summer. And though, under favorable conditions, they germinate in a few hours, and are ordinarily very short lived, under certain circumstances they may be blown about in a dormant state many days, and yet germinate; hence the earliest winter wheat is always liable to infection from this source. If, as Plowright suggests,[1] the teleutospores of one or more of the various species may germinate in the fall, it is very probable that there exists aecidium-bearing hosts in this country that have not as yet been pointed out from which there may be a direct infection.

Ind. experiment station, Botanical laboratory, April 1, 1889.

## LETTERS TO THE EDITOR.

### THE BACTERIA OF ENSILAGE.

In the fall of 1888, some observations were made upon ensilage at the experimental farm of the university of Wisconsin, with the view of determining the prevalent species of bacteria in the silo, and to see if any light could be thrown upon the phenomena of heating and fermenting, which goes on in the silo when ensilage is first put in. Samples of corn ensilage, which were what is called sweet ensilage, were taken from three different siloes.

A large number of gelatine plates were made after Koch's well-known method, but only a very few bacteria were found. Some of them were recognized as ordinary air bacteria, such as one might very naturally expect to find on the surface of any growing plant. In place of the large numbers of bacteria which might be ordinarily expected, many colonies of a Saccharomyces-like germ were found. When ensilage was exposed, in sterilized vessels, in an incubator at 38°C., colonies of this yeast germ developed as white patches all over the surface of the corn. The ensilage gave off a strong sour odor, something like fresh pickles in brine, which indicated considerable chemical change.

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[1] l. c.

Some time has been spent upon the morphological characteristics of the germ, but as yet little study has been given to the physiological problems involved. Not enough study has been put upon the subject yet, to state any generalizations, but there is probably some connection between the germ, and the fermentation which ensilage undergoes in its early stages. A more detailed study of the question may reveal its influence more correctly.

This note is given to call out from the readers of this periodical any remarks which may be pertinent to this important question.

H. L. RUSSELL.

Biological laboratory, univ. of Wisconsin, April 10, 1889.

## EDITORIAL.

As a general rule, persons engaged in scientific work are glad to extend courtesies to co-workers, if possible. However, this is unfortunately not true in the case of some of our station workers, but rather the reverse. We note in bulletin one of the office of experiment stations that no report was received from Florida concerning its officers and establishment.

As editor of this magazine, we have had occasion to correspond with all the stations to a more or less extent. It is desirable that we should have all station publications, that such of their contents as contain matter of importance may be presented to our readers. If necessary, we have respectfully applied to certain stations for these, but not always with success. In the case of one southern station, we wrote repeatedly, letters couched in all politeness, for bulletins, etc., explaining the purpose for which they were desired, yet neither bulletin nor letter did we succeed in securing from that station for nearly a year. To one of the northwestern states we wrote four letters at various intervals, requesting station publications, but eliciting no response. Finally we addressed a note to one of the board of control, which produced both bulletins and letter from the director. At least three other stations, to our positive knowledge, are almost equally discourteous, in their attention to correspondents. We do not believe that our own experience is exceptional, for we have evidence that it is not, and we do deem it a shame, that public servants, occupying non-political (?) offices, should completely ignore respectful communications from fellow workers, which call for reply. Common decency and common politeness demand that the director of an experiment station acknowledge in some form, polite communications from the workers at other stations. If they cannot do this, they certainly deserve the silent contempt of the body of the craft.

## RECENT LITERATURE.

ANNUAL REPORT OF CONNECTICUT EXPERIMENT STATION FOR 1888. New Haven, Conn., 1889, pp. 166.

This report is issued in two parts, the first containing 87 and the other 79 pages. Part first contains the Hatch bill and the action of the Connecticut legislature in reference thereto, and the reports of the secretary and treasurer and the director. The income of the station for the year was $18,606.15 and the expense $18,599.91. Of this sum $7,500 came from the Hatch fund. The Connecticut fertilizer law and operations thereunder are also given in detail in part first.

During the year 244 samples of fertilizer were analyzed and 887 samples taken by the authorized inspectors of the state. Full and admirable directions are given for sampling. Fluctuations in the value of fertilizing materials are given. Nitrogen in cotton-seed meal is shown to be the cheapest form, having cost during the year a little over 12 cents per pound. Phosphoric acid in Thomas slag costs about three cents a pound and soluble acid about eight cents a pound. Of potash salts, the potash ($K_2O$) in muriate is cheapest, costing about four cents a pound. Part first ends with a valuable review of the fertilizer market for the year.

Part second begins with a compilation of all American analyses of feeding-stuffs, presenting in a form convenient for reference the results of all work to date on that subject which has been done in this country.

The great differences noticed in analyses of identical feeding-stuffs by different analyists leads to the hope that these mean results may be much more accurate expressions of the composition of our feeding-stuffs than the data of any single analyist. The measures lately adopted by the association of official agricultural chemists, it is hoped will lead to better results in the analyses of feeding-stuffs.

Genuine molasses is described as having from 38 to 55 per cent. of cane sugar by direct polarization and showing a left-handed rotation after inversion with an acid. After inversion, at a temperature of 88°, such molasses shows only a slight right-handed rotation. Molasses adulterated with glucose shows a strong right-handed rotation, both before and after inversion.

Five samples of strained honey were examined, and all found to be adulterated. After inversion the samples of pure honey were found to have a high right-handed rotation at 86°. It is stated that pure honey is generally said to be a mixture of invert and cane sugar; which if so would show an almost neutral reading at 86°. This phenomenon it is said, is unexplained and will be further studied. It was shown by Dr. Wiley in 1885, that pure honey contained essentially invert sugar, together with other sugars optically active, a small portion of sugar optically inactive, ash, water and solids not sugar. It was shown also to contain dextrine, in some cases as much as four per cent. The presence of dextrine in pure honey explains the phenomenon mentioned above.

Part second ends with an account of field experiments with fertilizers, analyses of some feeding-stuffs and notes on the mechanical analyses of soils. In general it may be said that the report is fully up to the high standard of Connecticut work, and is full of valuable information.

THE STATE AGRICULTURAL COLLEGE OF THE STATE OF COLORADO. First Annual report of the agricultural experiment station, 1888. Fort Collins, Col., pp. 250, fig. 7.

The first report of an experiment station is usually prepared under difficulties, chief of which is the lack of precedent. Consequently matter is often published that is of no special interest, and occupies valuable space. This report, while presenting a most creditable typographical appearance, is no exception to the above, and might have been materially reduced in number of pages, by compacting arrangement, excluding certain matter, etc. The names on pages 25, 26 and 30 might have been much less expansive in arrangement, and likewise some tabular matter on other pages.

One cannot read the director's report, and then place much confidence in the report of the agricultural department which the director charges with "faulty weighing of seed," neglect and not properly doing work. If such is the case, the sooner this department is placed under new management the better.

The report of the horticulturist and botanist gives evidence of much work in not too many directions, which indicates that it probably is well done; while the main attention is given to fruits and vegetables, interesting papers on tobacco and apple twig blight are included.

The meteorologist and irrigation engineer present a report containing descriptions of the station meteorological outfit, a very necessary feature in a climate so variable as that of Colorado.

ANNUAL REPORT OF THE HATCH EXPERIMENT STATION OF the Massachusetts agricultural College, January, 1889, pp. 50.

The most valuable and extensive portion of this report pertains to the horticultural department, and it is noticeable that the character of the experiments is admirable. The reports of the horticulturist while very creditable would have been materially improved had they been more comprehensive. In the fertilizer experiments upon fruits and vegetables, nothing is said concerning the character of soil, arrangement of plants, amount and frequency of fertilizer application, etc. Further, brief tables are presented for the reader to draw his own conclusions, whereas had statements been made concerning the physical appearance of the plants as noted during various periods of growth, and conclusions deduced from the tables, by the experimenter, the general reader would have gleaned the results with greater clearness. The same criticism will apply most emphatically to the test of liquid manures for plants, recorded on page 47. What the "Flora Vita" is, how much manure was used, what the specific effect upon the plants of each lot was, how long a period of time the experiment extended, etc., the reader is unable to learn in the report. Yet these facts are all important.

The entomologist states that "leading authorities on the different groups of insects have decided to charge for their services when called upon to name insects;" this as a matter of interest to the officers of stations. The statement is obscure. Are the *authorities* to charge the farmer or the station, or is the entomologist of one station to charge another station for such a favor. We see no justice in this whatsoever, unless the authority is not at all connected with an experiment station.

There are two reports of the entomologist, and two by the horticulturist, each separated from its companion in a most unpleasant manner, by having the other between them.

We have already commented upon the excellent character of the work in progress at this station, and have previously made abstracts in this journal of some of the matter in this report, which was issued in bulletin form.

ARKANSAS INDUSTRIAL UNIVERSITY, FAYETTEVILLE, ARK. First annual report of the agricultural experiment stations of the, 1889, pp. 134.

Twenty-seven of these pages are devoted to horticulture, and describe the condition of strawberry and grape varieties planted at the stations, give a list of some other fruits and briefly note characteristics of potato varieties. A number of serviceable tables of analyses of sorghums are given, covering 19 pages. Brief experimental results with Texas fever, mangold wurzel, maize, and dehorning are chronicled. Some considerable work is done with cotton, in testing varieties and fertilizers. The botanical and entomological reports are very brief. This station appears to be grappling with some of the more important questions in Arkansas agriculture, and has a good start, but this report does not exhibit the work to advantage. The arrangement of the matter might have been decidedly bettered, as there seem to be no system in it. Experiments of the same class should be arranged under one specific heading, for convenience sake. The first experiment in the report is by a farmer, and one is in doubt just when this man's work ends. On page 41 begins a report on "horticulture," yet page 40, facing it, has a report on peas, covering two-thirds of a page. The most extensive and valuable work, is with sorghum, and we judge this in this state to be in the right direction. The article on dehorning is also creditable.

Considering the short length of time the stations have been in operation, this report we believe to be too verbose. There is but little matter of value in a large part of the horticulturist's report, for most radical changes might be necessary another year in the statements concerning variety growths. It is better for a station to publish a little that is good and that will be appreciated by both practical and scientific people, rather than present so much miscellaneous substance that one must glean with care to find the good grain. It is a chronic weakness of most first reports of stations to contain inferior material with which to fill up.

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# ABSTRACTS.

## DOUBLE FLOWERS CAUSED BY MITES.

(By UDO DAMMER: *Gardener's chronicle*, March 16, 1889.)

These experiments were reported to the Imperial academy of Vienna by Prof. Peyritsch of Innsbruck.

A large number of experiments tend to show that double flowers may be artificially produced by the agency of a mite (phytoptus), and these were brought about by discovering the insects on a wild double flower of *Valeriana tripteris*. These mites were transferred to other plants, chiefly of the orders Valerianaceæ and Cruciferæ, and a few Scrophularineæ, Commelynaceæ, and even others, but the best results were obtained in the first named.

Various forms of doubling were secured, such as petalody of the stamens and pistil, prolification and duplication of the corolla, etc., as well as torsions and fasciations of the shoot. The leaves were also affected, the margin showing teeth like those of a comb. By infecting the plant at different times either the leaves or the flowers may be influenced, and it appears that the parasite must attack the organ in its earliest stages. Prof. Peyritsch thinks that there are certain mites which produce flowers in certain plants, as the mites in which he was particularly interested were always most abundant in certain species, and less so in others.

The plants of Valerianaceæ experimented upon include, valeriana (12 sp.), valerianella (three sp.), fedia, centranthus (three sp.), patrinea. Abnormal leaves were induced in ten species of valeriana, all of the valerianellas, two of centranthus, and in fedia. Double flowers were produced in valeriana in six cases, three times in centranthus, and once each in fedia and valerianella.

Among the Cruciferæ, biscutella, *Brassica nigra*, *Capsella bursa-pastoris*, *Cochlearia officinalis*, eruca, lepidium, malcolmia (two sp.) and *Sisymbrium Sophia* were experimented with. The results were variable. In many cases (cochlearia, eruca, lepidium, sisymbrium, brassica, capsella) bracts were formed resembling the leaves, but of smaller size; proliferous flowers were formed in brassica and biscutella; petalody of stamens occurred in cochlearia and eruca. In *Linaria cymbalaria*, peloriate flowers and other changes were found.

The investigator says, the results are effective or not, according as the plant is a good host plant for the mite —a good host plant being quite crippled. Among the valerians, those plants with their leaves were more easily affected than others with more substance.

The phytoptus infesting the buds of the hazel, corylus, and which causes malformations in it, was transferred to plants of brassica, sisymbrium, capsella and myagrum. Bracts were, in consequence, developed in sisymbrium, capsella and myagrum, in which as in most crucifers, the bracts are generally wanting; and in the last named double flowers.

*Bellis perennis* gave the same results when infected by the mites from valeriana, campanula or corylus—viz., the production of very hairy leaves, but not toothed, the disc florets green, and the involucral bracts elongated.

It was observed that after infection growth in length was slow, but lateral bud development was accelerated unless other abnormalities appeared.

## THE PATHOLOGY OF ACTINOMYCOSIS.

(By G. A. BODAMER: *Jour. comp. med. and surg.*, x, (1889) pp. 105-126.)

The author thinks he is probably entitled to priority in demonstrating the actinomyces in the United States.

The disease is known in this country as "swelled head," and usually affects the jaws of the graminivora, particularly the ox tribe. The disease formerly was known under a variety of names, but in 1877 Bollinger studied and named it actinomycosis, on account of a fungus found to inhabit this lesion.

In the animal, the disease manifests itself as a primary disease of bones, forming tumor masses, secondarily giving rise to fistulous openings toward the exterior, and finally, metastasis of the internal organs occurs, particularly the respiratory tract where nodules are seen not distinguishable from miliary tubercles.

The malady must be classed with the group of granulation tumors. The author has examined cases in both Germany and Europe, and from four cases diagnosed in this country, gives microscopical notes. The tumor consisted of five distinct morphological constituents, viz: (1) the tissues forming the boundary of the tumor; (2) the bony frame work; (3) the new growth proper in its solid parts; (4) the liquified products; and (6) the yellow granules scattered throughout the whole of the above constituents.

The tissues making up the boundary of the tumor, were not distinct, but gradually shaded off. The surrounding soft parts were as a rule much atrophied, and infiltrated by cells from the new growth. Sometimes the tumor surface projected, but as a rule it was smooth. Yellow granules composed of masses or tufts of fungi were found in the most peripheral portions of the tumor.

The bony framework forms round or irregular spaces of various sizes, which enlarge as does the bone tissues, and produce bony excrescences or exostoses in the cavities filled by the new growth. These bony excrescences had the structure of young callus tissue. Large osteoclasts make up their bulk. The cells are embedded in a granular matrix.

The new growth proper, which forms the softer portions of the tumor, is sometimes nearly semi-liquid, white, often glistening, sometimes milky appearing, again congested and red. Under low magnifying power, a section presents granular appearances through which connective tissue pass in various directions, dividing the tissue into many partitions. At the center of the nodes the granular appearance predominates, while at the periphery it has a fibroid appearance.

The liquifying products from necrotic changes were quite abundant in every specimen, the center of the larger nodes and sometimes the whole of a large node undergoing this change. Under the microscope, quite distinct alveolar connective tissue, intermingled with leucocytes was often noted.

The yellow granules are clusters of the fungi, which form a necessary part of the anatomy of the new growth, or is very common. If the fungus had not been present in all the author's cases, the new growth would have to be called sarcoma. No definite distribution of the fungus could be made out. It is more numerous in the liquifying parts. In most instances, masses containing the fungus, were calcified.

The author carried out inoculation experiments, in which marked lesions were formed in six out of 13 animals, though the results were unsatisfactory in not being repeated in sufficient number. It was shown that the lesions produced by inoculation do not differ from tuberculosis, except in containing, instead of the tubercle bacillus, the actinomyces fungus or no fungi at all.

A very good bibliography is given, and the article is illustrated from photographs.

## COMPOSITION OF MILK AND MILK PRODUCTS.

(By DR. P. VIETH. *The analyst:* April, 1889, p. 69.)

The annual report of Dr. Vieth, chemist to the Aylesbury dairy company of London is always of interest, presenting as it does the averages of a very large number of milk analyses.

In 1888, 12,682 milk samples were taken from the railway shipments on their arrival at the dairy, and 2,545 samples were taken by inspectors employed by the business from the men, while the latter were serving their customers. The following table shows the monthly averages of the results referring to these samples.—

| Month. | Samples taken. | | | | |
|---|---|---|---|---|---|
| | On arrival. | | | | On delivery. |
| | Specific grav. | Total solids. | Fat. | Solids not fats. | Total solids. |
| Jan.......... | 1.0325 | 12.97 | 3.79 | 9.18 | 13.0 |
| Feb.......... | 1.0325 | 13.00 | 3.81 | 9.19 | 13.0 |
| March...... | 1.0325 | 12.90 | 3.73 | 9.17 | 12.9 |
| April........ | 1.0324 | 12.81 | 3.68 | 9.13 | 12.9 |
| May......... | 1.0324 | 12.82 | 3.69 | 9.13 | 12.9 |
| June......... | 1.0324 | 12.83 | 3.69 | 9.14 | 12.9 |
| July...... ... | 1.0320 | 12.82 | 3.76 | 9.06 | 12.9 |
| Aug. ........ | 1.0319 | 12.84 | 3.80 | 9.04 | 12.8 |
| Sept......... | 1.0322 | 13.06 | 3.94 | 9.12 | 13.0 |
| Oct...... .... | 1.0325 | 13.09 | 3.89 | 9.20 | 13.0 |
| Nov. ........ | 1.0322 | 13.18 | 4.03 | 9.15 | 13.1 |
| Dec ......... | 1.0321 | 13.01 | 3.91 | 9.10 | 12.9 |
| Year. aver. | 1.0323 | 12.94 | 3.81 | 9.13 | 12.9 |

With regard to specific gravity of milk, as an index of its normal condition, Dr. Vieth calls attention to a phenomenon long but not widely known, viz: the rise in specific gravity of milk following and continuing sometimes after it is drawn from the udder. Fifteen samples showed a specific gravity of 1.0296 directly after milking; after 16 hours it had risen to 1.0309, an average of .0013. In two instances the increase was .0020, in six .0015 and in seven .0010. According to Recknagel, the specific gravity of milk becomes stationary, *i. e.*, normal after five hours or less, if cooled below 15° C. At temperatures above 15° C. this contraction goes on for 24 hours or more. If after the density has become normal, it be warmed to 40° C., it will have decreased again and requires some time to regain the normal condition.

Recknagel ascribes the phenomenon to molecular changes in the casein.

## ACTION OF FERROUS SULFATE IN VARIOUS SOILS.

(By P. M. DELACHARBONNY and L. DESTREMX: *Bied. Centr.*, 1889, 9-14.)

Wheat was sown on soils containing quantities of iron varying from 1.740 to 4.321 per cent. It was observed that the sulfate was productive of increased yield only when the iron of the soil was present in small quantities, the increase ceasing when the percentage of ferric oxide reached three per cent., and was detrimental when the percentage was four per cent. In a second experiment, when potatoes were the crops (the land being deficient in lime, it was added in the form of sulfate and carbonate) the same results as to yield were noted. The same results were likewise observed when lucern and hay were grown. Ferrous oxide, appears to be a good manure for pastures in which much moss is present, and may be applied at the rate of 300 kilos per hectare or more if necessary. It may be applied dry or dissolved in water in the ratio of five kilos per hectolitre, and in the month of March.

*Ab.: Jour. chem. soc., 1889, p. 436.*

## CRANBERRY LEAF GALLS.

(By FR. THOMAS: *Insect life*, 1, p. 279.)

These are not made by phytoptus, but by an unicellular fungus of the genus synchytrium. The cranberry gall is chalice shaped. On the bottom of the crimson chalice (inside) one cell is much increased in size, the "host cell" of the parasite. It contains only one sub-globular fungus cell, 0.086-0.171 mm. in diameter, which has a brownish, smooth wall; its contents are colored by chrome yellow.

In autumn the galls become black and brittle and break off. The resting spores fall to the ground, or are set free by rotting of the leaf. Next spring the spore germinates, produces zoöspores, swimming in water for some time and attaching themselves to epidermal cells of a young cranberry leaf, to recommence the production of galls. A long flooding of the bog simply aids in distributing the disease.

### LEGUMINOSEÆ IN ACID SOILS.

(By P. DE MONDESIR : *Comp. rend.*, cviii, 62–64.)

It is generally supposed that the pressure of calcium carbonate in a soil is essential to the proper growth of leguminoseæ which can be used as fodder. The author finds, however, that lupins, clover and other leguminoseæ will grow luxuriantly in the acid soils in the department of La Manche, provided that the soils are mixed with phosphates, or with phosphates and potassium chloride. No improvement was obtained by mixing the soil with lime without phosphates. The superphosphates, which are themselves acid, act even more beneficially than the normal phosphates. It follows from these results that calcium carbonate is not essential, but in presence of phosphates and potassium salts, legumes can obtain sufficient calcium from the compounds of the latter with the humus substances which are present in the soil.

*Ab.: Jour. chem. soc., 1889, pp. 434.*

### KAINIT AS PROTECTION AGAINST FROST.

(*Sächsische landw. Zeitung*, 1888, p. 598–599.)

A field was strewn with kainit, and over this a thin layer of potato-vines, and although the temperature fell to—6° R. during the night, the surface of the earth did not freeze. Another time kainit alone was strewn upon the surface. At first the soil did not freeze at all. Later a thin layer became frozen, but not at all to be compared with other parts of the field. In a third experiment, two small heaps of potatoes were covered with a thin layer of earth, and one of these strewn with kainit. On the following morning the potatoes without kainit were frozen throughout ; the others however were unharmed, and even the earth only slightly frozen. It is to be noted that in all cases the kainit was very thinly applied.

*Ab.: Bied. central-blatt f. ag. chem., 1889, pp. 204.*

## EXPERIMENT STATION ABSTRACTS.

## VEGETABLE PHYSIOLOGY.

### AN INVESTIGATION OF APPLE TWIGS.

(*Iowa agricultural experiment station. Bulletin No. 4, p. 104–132.*)

This investigation was conducted by Prof. B. D. Halsted, primarily to determine the conditions in which the various food materials formed by the trees were stored up for future use, and to note differences in quantity and quality in these substances.

In testing for starch, the iodine solution was used. Starch is found quite generally in the pith, medullary rays and wood pith of the varieties of apples examined, and usually in the form of compound granules which separate quite easily. With the varieties, starch was noted as follows:

Tetofsky: Section one inch below tip. Pith well filled, and medullary rays, but none outside the wood. At base of twig starch plenty. In lengthwise sections through center of twig and bud, starch did not extend into the base of the lateral bud beyond the line made by continuing that of the outside of the wood above and below the bud. The starch bearing cells, designated as wood pith, are usually four times as long as broad. A parallel study was made of this variety upon twigs of different sizes and a lower percentage of starch was found in the small than in the large.

Whitney: No starch in terminal portions, but in abundance in central pith, medullary rays and wood pith. Like Tetofsky.

Wealthy: Same as two preceding.

Citronat: Transverse section 15 in. from terminal bud. Outer part pith, close to wood, cells packed with starch, each cell being punctured by 30 to 40 pits or pores. Starch abounds in terminal parts of twig, including basis of large bud scales and stalks of remaining leaves. Twigs from a cellar showed no starch in buds, while immature ones from the nursery contained an abundance.

Boiken: Starch generally distributed, but not densely stored; was considerable in soft bark. Repka Keslaja and Red June: Is no appreciable difference in amount of starch, and its distribution in pith and medullary rays, the greatest difference being the lack of starch in the buds and bark of the former and its presence in the latter.

Repka Keslaja, Recumbent and Hibernal presented no marked differences in wood or pith structure. None showed starch in the buds.

Red June, Wine sap and Ben Davis agreed very generally with the preceding three, excepting that the former were usually well matured and the pith lignified a short distance below the terminal bud. With Ben Davis, many twigs had no well formed terminal bud, the cone of lignified pith was lacking, and starch was not shown in a definite line as in ripe twigs. The same may be said of the Red June in many respects.

Duchess and Landsberger rennet: Are much alike in outward appearance. Half inch from terminal bud tip in Duchess is well formed lignified cone of pith which is very rigid; lower down the twig this is not so much lignified. The cone cells an inch below tip are densely packed with starch, and a foot below, the pith is fairly well filled, while it abounds in the medullary rays. In

Landsberger the cone of lignified cells is imperfectly developed, and the whole twig is less substantial than Duchess. The porosity of the two sorts, and microscopic qualities were practically alike, but the quantity differed, the Duchess zone being twice as thick as the other, and pith correspondingly smaller.

The writer concludes that starch prevails in all sorts of apples, and is most abundant in those twigs which have come to maturity. In "water sprouts," starch occurs mostly in the outer pith and medullary rays, and especially in near buds. Twigs from tree tops and fully matured, have all the parts well developed, and pith, buds and wood well charged with starch. Nothing in the quantity, quality or disposition of the starch could be taken as a distinguishing variety characteristic.

Grape sugar was generally present in variable quantity in all lateral buds, but least in the tip of twig. Cane sugar and dextrine were likewise present to a slight extent.

The albuminoids were but slightly present in the pith at the base of an old apple twig, very little in the wood zone, abundant in cambium layer, and in largest per cent. in buds, in the latter, when mature, making up a large part of the cell contents. Twenty-five varieties exhibited albuminoids as red particles when treated with the Millon test. The albuminoids, like starch, are a test for maturity instead of distinguishing the variety.

Crystals, principally of one sort, were continually met with in all sections of all varieties of apple twigs. Rarely found in old pith, and have not been seen in old wood, but are very abundant just below the growing tips of all buds for a half inch or so back of the tip.

Tannin, as recognized by salts of iron is abundant, especially in the rind and the inner bark close upon the cambium and between it and the zone of bast. The varieties do not differ much in amount.

Varieties of apples do not vary much in the thickness and firmness of the bark, and the wood fibres and vessels are so much alike that equal areas give equal resistance. The grittiness of grafters resides in the pith, medullary rays and wood pith, and is due to the thick, hard cell-walls.

## ANALYSIS OF APPLES.

(*Iowa agricultural experiment station, Bull. No. 3, pp. 82-91.*)

The following numbers of apples of the varieties named, were taken for analysis: Fameuse, 24; willow twig, 16; cross, 14; Withe, 14; silken leaf, 24; Ostrakoff's glass, 19; Borsdorf, 17; Soulard crab, 26; Scott's winter, 13; Winsted pippin, 11 anb Iowa greening, 13.

Every sample for analysis was obtained by taking an equal number of slices from each apple, these being from peel to core.

The following is the method of analysis:

I. Moisture and dry subtance were found by drying at 100° to 110° C. to (nearly) constant weight.

II. In analysis of uncooked samples, solids soluble in cold water, pectins, free acids, sucrose and glucose (with like behaving subtances) were determined in a solution prepared thus: 200 grams of samples bruised to pulp in water in mortar, extracted six times with cold water and the liquid passed through fine cotton cloth, the pulp being each time allowed to soak at least a half hour. The sixth extract was tested separately for glucose, and if a sensible amount was found, it was added to that obtained from the first five extracts, and these measured and used for analysis.

(a) For solids soluble in water, six c. c. of the clear filtered liquid were dried to constant weight on asbestos, after Babcock's method for drying milk, using glass wool for cotton.

(b) Sucrose and glucose were determined (after defecation of the liquid with basic lead acetate and removal of the lead by sodium carbonate) by the cuprous oxide, ferrous sulfate and potassium permanganate method, with due regard to the amount of sugar present and concentration (Soxhlet.)

(c) Soluble pectins were found by evaporating 50 c.c. of the clear filtered liquid down to three or four c. c., adding excess of 90 per cent. alcohol, filtering on asbestos after some hours, washing with alcohol and drying at 100° to 110° C.

(d) Free acid was found by titrating 100 c. c. of the filtered liquid with deci-normal soda, phenolphthalein being the indicator. Results reckoned as malic acid.

III. In analysis of cooked samples, methods a. b. c. were applied to a solution obtained thus: 50 grams of the raw sample with 200 c. c. of water, were heated on the steam bath for two hours, then boiled for one-half hour, filtered and pressed through fine cloth, the pulp washed and pressed repeatedly, and the entire liquid made to one liter.

IV. For pectins soluble in dilute alkali, boiled 30 grams of the sliced apple with 200 c. c. water for two hours (with reflux condenser), when cold added 40 c. c. sodium hydrate solution, let stand 24 hours, made to one-half liter, filtered, acidified 50 c. c. of filtrate with acetic acid, added 100 c. c. of 90 per cent. alcohol, let stand 12 hours, filtered on asbestos, washed with alcohol and dried at 100° to 110° C.

The following table shows the principle results of the research. U. refers to uncooked and C. to cooked fruit. S. means sucrose and G. glucose. The figures are per cent.

| Name. | Dry Sub. | Soluble solids. U. | Soluble solids. C. | Acidity as malic acid. U. | Acidity as malic acid. C. | Uncooked. S. | Uncooked. G. | Uncooked. Total. | Cooked. S. | Cooked. G. | Cooked. Total. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fameuse......... | 14.4 | 12.80 | 13.88 | .394 | .437 | 3.29 | 8.31 | 11.60 | 1.63 | 9.85 | 11.48 |
| Willow twig... | 14.3 | 12.68 | 13.74 | .683 | .691 | 3.87 | 6.79 | 10.66 | 1.25 | 10.05 | 11.30 |
| Borsdorf....... | 14.4 | 12.20 | 13.78 | .418 | .457 | 2.82 | 7.48 | 10.30 | 1.45 | 9.41 | 10.86 |
| Winste dpippin | 14.2 | 11.58 | 12.94 | .577 | .680 | 1.30 | 8.33 | 9.63 | .23 | 9.07 | 9.29 |
| Ostrokoff's gl's | 11.8 | | | .622 | .636 | 1.78 | 7.68 | 9.46 | .92 | 8.68 | 9.60 |
| Silken leaf...... | 11.8 | | | .837 | .920 | 1.46 | 7.80 | 9.33 | .30 | 8.87 | 9.17 |
| Scott's winter.. | 12.8 | 11.20 | 12.10 | .960 | .970 | 3.06 | 6.07 | 9.13 | .59 | 8.36 | 8.95 |
| Iowa greening. | 11.7 | 9.75 | 10.70 | .117 | .100 | 1.25 | 7.88 | 9.12 | 1.47 | 7.75 | 9.22 |
| Cross.............. | 12.5 | 11.17 | | .423 | .457 | 2.13 | 6.80 | 8.93 | .92 | 7.89 | 8.81 |
| Wythe........... | | 11.84 | 12.72 | .646 | .713 | 2.05 | 6.83 | 8.88 | .53 | 8.42 | 8.95 |
| Soulard crab. .. | 15.3 | 12.30 | 13.90 | 1.124 | 1.204 | 3.11 | 5.15 | 8.26 | .77 | 7.78 | 8.56 |
| Average.... | | 11.79 | 12,97 | .618 | .660 | 2.37 | 7.20 | 9.57 | .94 | 8.74 | 9.67 |

The pectins extracted by water and by alkali are omitted from this table, as well as moisture.

## A CHEMICAL STUDY OF APPLE TWIGS.

(*Iowa agricultural experiment station. Bulletin 4, pp. 99-103.*)

The station chemist, G. E. Patrick, made a study of the twigs of four varieties of apple, to learn whether there exists in mid-winter, any differences in composition between the new growth of those varieties of apple which are hardy, and those which are not hardy in central and northern Iowa. The varieties studied were, Duchess of Oldenburg, Borobinca, Ben Davis and Boiken. (1) Three inches of the extreme ends of the twigs were taken for extraction. (2) The next four inches for estimating moisture and protein. (3) The next one and one-half inch for specific gravity. (4) The next two inches were held as reserve. (5) The next two inches were used in determining the ash.

The results are as follows:

1. Tender varieties contained some more extractable matters than did hardy.
2. The former contained a smaller total of sugars, dextrine and other water-soluble substances, convertible into glucose by dilute acids.
3. Tender varieties had more free acids than did hardy, and more soluble pectins and less dextrine than did hardy.
4. Of extractive matter undetermined, the tender varieties contained the most.
5. Protein showed wide variations in the different samples, but not on the lines of tender and hardy. Ash was nearly the same in all.

## PLAT EXPERIMENTS.

### FIELD EXPERIMENTS WITH SUGAR CANE.

(*Louisiana sugar experiment station. Bulletin No, 20, pp. 198-266.*)

The following is an abstract from the summary of results. The director states that the year's work has emphasized in a most decisive manner the deductions of former years.

(1) The upper part of the cane is equal if not superior to the lower part in both first and second years.

(2) The number of stalks per plat created little difference in the stubble,

(3) Seed from good first year stubble has given as good results the first and second year as seed from plant.

(4) Stubbles come equally as well from the original sprouts as from suckers.

(5) Nitrogen in some form is much needed by our soils. Sulfate of ammonia furnishes it in better form than any other, though there is no marked superiority over any of the leading forms.

(6) Excessive quantities of nitrogen are always injurious to sugar content. From 21 to 42 lbs. are suggested as the limits. To secure maximum results nitrogen should be combined with mineral manures.

(7) Mineral manures alone are without decided effects, but with nitrogen produce the highest results.

(8) Phosphoric acid is best supplied in the soluble form, as acid or superphosphate.

(9) Excessive quantities of phosphoric acid, while not beneficial, are not lost, as they may serve the plant in the future. The limits of profitable production seem to be from 40 to 75 lbs. per acre.

(10) Potash in any form, in small quantities is without visible effect, on tonnage or sugar content, but if heavily applied, increases tonnage without enhancing sugar content.

(11) The influence of pea vines turned under is more perceptible to the stubble than the plant cane.

(12) Draining lands by tile has increased the yields in 1886-87 about 35 and in 1888 about 50 per cent.

(13) The effects of tiles are yearly increasing.

(14) Growing cane in narrow rows during 1888 increased tonnage and sugarage per acre.

## AGRICULTURAL PHYSICS.

### STEAM VS. HOT WATER IN HEATING GREENHOUSES.

(*Massachusetts agricultural college experiment station. Bulletin No. 4, pp. 3-7.*)

Two greenhouses 75x18 ft. each, were built as nearly alike as possible. Two boilers of the same pattern were put in, one fitted for steam and the other hot water. The steam boiler heated the east and the hot water the west house. The temperature of each house was taken at 7:30 and nine A. M. and three, six and nine P. M. during January and February.

During January the hot water boiler consumed 688 lbs. less of coal than did the steam boiler, and in February 720 lbs. less. The temperature of the hot water room averaged 1.7° higher than that heated by steam. The hot water heat was more even than that from steam.

## AGRICULTURAL SCIENCE NEWS.

Mr. L. O. Howard, in *Insect life* for March, describes three new parasites of the fluted scale (*Icerya purchasi*).

The April bulletin of the Royal gardens, Kew, contains a list of new garden plants described to the end of the year 1888, from 1887.

Jas. W. Robertson, professor of dairying in the Ontario agricultural college has issued a 37 page report of his work during the season of 1888.

The annual report of the director of the weather service department, with some most excellent rainfall charts, makes up bulletin 43 of the Michigan agricultural college.

Mr. C. Fruwirth, of Vienna, Austria, has been appointed to a professorship in the agricultural college at Mödling, Austria, and also to the management of the hop trial grounds at Fürstenfeld in Styria.

Prof. J. P. Sheldon, for nine years past professor of dairying at the college of agriculture, Downton, England, and author of "Dairy farming," the most comprehensive work upon the subject, has resigned his chair at the college.

A movement is being made to establish dairy schools in connection with the university college of North Wales, towards which a government grant was recently given. A limited liability company, with a nominal capital of $5,000 has been formed for the purpose of carrying on the schools.

The Scotch Dairy school at Kilmarnock is awakening considerable interest in that country. The government has given it a grant of $850. Pupils come from all parts of the country. Members pay a fee of $1.25 weekly, and non-members $2.50 per week. Daily tickets are issued at smaller rates, enabling farmers' wives to come any day most suitable to themselves. Pupils find their own board and lodgings.

*Errata.* Through carelessness of printer, who is entirely responsible for not correcting, the following changes should be made in April AGRICULTURAL SCIENCE. Page 79, eleventh line from bottom, "saporification" should be *saponification*. On page 80, under Harrington's test, in second line of "melting point," "3.4" should be 34 On page 93, twentieth line from top, "1888" should be *1889*. On page 94, eight lines from top, "plaisade" should read "palisade."

Profs. G. Briosi and F. Cavara of the Royal agricultural school at Pavia, Italy, are publishing a work on the fungi injurious to cultivated plants. It is issued in a series of parts, each part of which is devoted to 25 species, containing specimens of the fungi themselves, together with drawings and microscopical illustrations of fungi in various stages of development. The first part has already been issued. It is a work of special value to experiment stations.

Dr. Austin Peters, before the Massachusetts veterinary association recorded a case of tuberculosis in a dog, transmitted from mankind. A woman suffered from consumption for some time, and ejected her sputa into a spittoon. The dog, then a puppy, acquired the habit of eating this sputa. A post-mortem examination of the dog showed phthisis of both lungs, with a large abcess in the posterior lobe of the left. There was also a little puroserous fluid in the thoracic cavity, and a somewhat fatty liver. Scrapings from the abscess, under the microscope, revealed large numbers of tuberculous bacilli.

Michael Eugene Chevreul, the French chemist, notable for his scientific attainments and his great age, died at Paris, April 9th. His long life linked the days of alchemy with the modern science of chemistry, he having witnessed the development of the chemical theory, as at present accepted, almost from its beginning. At 20 years of age he was director of Vauquelin's laboratory; at 30, professor of chemistry at the Gobelin tapestry manufactory, and director of their dyeing establishment. At 40 he was member of the academy of sciences and never missed a meeting of the same up to his 100th birthday. His publications reached an extraordinary number, the more important of which being upon the chemistry of fats and coloring matters. His studies of fats, soaps, glycerine, etc. were the starting points for the great industries dealing with these substances. Had he lived until Aug. 31st he would have been 103 years old.

We quote the following from *Science*, xiii, 323. The alleged resistance offered by American grape vines to the ravages of the phylloxera, has recommended those vines to wine growers of Europe, where the pest has made its presence felt. Much uncertainty has existed among the growers as to the particular variety best adapted to resisting the insect ravages, and some disagreement has also been noted between those who favored grafting American cuttings on French vines and those who proposed to replace the French by the American article entirely by planting the latter in the place of the former. Dr. Geza Von Howath, of a Hungarian experiment station, who has been studying the subject for seven years past, has published in detail the results of his experiments. There is but one American variety, and that the *Vitis rotundifolia*, or Scuppernong, that will successfully resist any and all attempts of the pest upon its roots. Unfortunately, the European growers will not plant this grape, owing to its, to them, unpalatable taste, and also to the fact that European vines will not graft well with it. All other varieties of American vines are more or less liable to infection, and many are said to be as vulnerable to the pest as any European vine. Many varieties depend on differing soils and other conditions to render them free of the infection. The Concord grape is classed as one that offers resistance to the pest only under exceptional circumstances. Other varieties which are more or less liable to infection, are the York, Madeira, Herbemont, Jaques, Cunningham, Clinton, Taylor, Elvira and Othello. All American varieties not covered by the above names, it is said, either do not withstand the phylloxera at all, or have not yet been sufficiently tested as to their ability to do so.

## EXPERIMENT STATION ITEMS.

"Rational feeding" is the title of bulletin 21 of the Indiana station, by Carl A. Wulff. This is a theoretical discussion of the subject.

Bulletin five of the Missouri station is upon field experiments with corn, and is by P. Schweitzer, the chemist. Chemical analyses are given of soils and metorological data also published, with nine diagrams.

The first annual report of the Nevada station is a 17 page pamphlet signifying the existence and organization of the station. Up to the time of publication, no research had apparently been begun.

Bulletin 33 of the Massachusetts state station is on commercial fertilizers, and contains the trade values of fertilizing ingredients in raw materials and chemicals for 1889. Analyses of fertilizers are also given.

Bulletin three of the Iowa station, for Nov. 1888, discusses the characteristics of hardy and tender fruit trees; chinch bug diseases; some injurious fungi; promising new pears; promising grasses of the northwestern territories; analyses of apples; and the work in crossing.

Prof. Edward D. Porter, has resigned his directorship of the Minnesota station, and Nelson W. McLain, for some years special agent in conducting experiments with bees for the United States department of agriculture, has been elected as his successor.

Geo. F. Atkinson, botanist and entomologist to the South Carolina station has given in bulletin four of that institution, an excellent popular entomological discussion of some of the more common and injurious insects of the state. Three pages are devoted to the club root of cabbage, as produced by fungi.

Bulletin four of the central experimental farm at Ottawa, Canada, contains a very exhaustive account of Ladoga wheat, a variety imported to Canada from near Lake Ladoga, north of St. Petersburg, Russia. This wheat was brought from a very cold region, having short growing seasons, in order to secure a first quality variety of early maturity in Canada. The results are promising.

The first annual report of the Mississippi station covers 62 pages, and presents an excellent typographical appearance. The station funds became available so late in the season but little field work could be accomplished, only a few fertilizer tests with corn, cotton and sweet potatoes being done. Some considerable space is given to descriptions and tables of matter pertaining to fertilizers, feeding stuffs, etc. The report would be materially improved by an index.

The Connecticut station, at New Haven, has published in bulletin 96, for January, an important contribution on the valuation of feeding stuffs, as it represents a class of work heretofore neglected in America. Analyses are given of quite a variety of feeding stuffs, upon which is placed a valuation as deduced from analysis. A table is also given, representing the average composition of feeds for dairy stock.

The Alabama cane brake station publishes in bulletin three an almost entirely tabular bulletin, concerning results upon corn upon drained and undrained soil, with fertilizers, methods of preparation, and the effects of pulling fodder. Fields of forage crops are given, and notes upon drainage. The table showing the influence of drainage upon rainfall is quite interesting, for in every case the soil was appreciably warmer when drained. It is a question worthy of comment: why does this station publish the results of so many experiments in tabular form, and make no attempt to explain the results of the same?

The office of experiment stations of the United States department of agriculture has published as its first bulletin, data concerning the organization of the agricultural experiment stations in the United States. An introduction is given by the secretary of agriculture. The organization and first work of the office of experiment stations, is explained, after which are given lists of the various stations, agricultural and mechanical colleges, officers and workers, legislation concerning experiment stations, and a brief account of the experiment station movement in the United States by A. C.

True, Ph. D. It will serve as an exceedingly interesting and valuable reference document.

In the second bulletin of the Nevada station, for September 1888, printed in 1889, the botanist and chemist discusses "the investigation of the interdependence of plant life and climatic conditions of Nevada," with tables of meteorological records. We confess, we can see no better way for a station in such an embryo condition as that of Nevada to do, but to publish such matter. But it is none the less unfortunate that an experiment station should feel obliged to issue such a bulletin, when farmers demand information oi so much more pertinent value.

"Fertilizers and fertilizing materials" is the title of bulletin five of the New Hampshire station. This is an educational bulletin, but gives no results from original research. Bulletin six of the same station also deals with the fertilizer question, and reports upon plat tests with manures. The author's conclusions are that if more potash were used, better results would as a rule be secured in growing farm crops. The type used in some of the tables is unfortunately very small, and the arrangement in some cases is not suited to convenient reference; this is especially true on pages 14 and 25. More care should have been exercised in the composition of this bulletin. In some cases bad grammar is used.

Prof. S. T. Mansard has conducted some interesting and valuable experiments in the greenhouses of the Mass. agricultural college, with evaporated sulphur to destroy fungus growth and injurious insects. Sulphur is put in an iron basin or kettle, and heated three or four hours twice a week, in the greenhouses on an oil stove. The fumes destroyed the rose mildew *Erysiphe* (*Sphærotheca*) *pannosa*, lettuce mildew *Peronospora gangliformis* to a considerable degree, and the red spider completely. Experiments were also made on the plum wart (*Sphœria morbosa*) by painting it with linseed oil, turpentine and kerosene, all of which destroyed the wart completely. The substances were applied when the warts first appeared.

Bulletin five of the Nebraska station is "on certain injurious insects of the year 1888," by Lawrence Bruner, the entomologist. It contains 19 very excellent illustrations. The insects reported upon are as follows: The box elder plant louse (*Chaitophorus negundinis*, Thos.); green striped maple worm (*Anisota rubicunda*, Fabr.); large willow saw-fly (*Cimbex Americana*, Leach); apple tree flea beetle (*Graptodera foliacea*, Lec.); apple-twig borer (*Amphicerus bicaudatus*, Say); corn-root worm (*Diabrotica longicornis*, Say,); army-worm (*Leucania unipuncta*, Haw), and "cut-worms." Bulletin six of the same station contains a report of progress, history of fields and description of the animals available for experiment; a record of field experiments, which are nearly entirely variety tests, and meteorological records.

The West Virginia station has published three bulletins in quite rapid succession, since January. Bulletin two is by A. R. Whitehill, and discusses the history, properties, source of the ingredients, mode of application and uses of commercial fertilizers. No analyses are given. Bulletin three is on the birds of West Virginia, by W. D. Doan. It contains little of interest to any but ornithologists, and we fail to see why such a publication should emanate from an agricultural experiment station, unless strictly bearing upon agriculture. Bulletin four is by A. C. Magruder, on the creamery industry: its adaptability to West Virginia. Well drawn floor and elevation plans of a creamery, with specifications for its constuction are given, while much additional data is given pertaining to the creamery business. Such a bulletin as this ought to be eminently serviceable to the farmers of the state, who propose to enter into this business. It is a valuable, practical exposition of the subject.

The report of the officers of the experimental farms of Canada, for 1887, embraces 57 pages, and was addressed to the minister of agriculture on Dec. 31, 1888. While the report contains information of value to farmers, it contains almost no original research, owing to the new organization. The central farm consists of 466 acres, and is situated near the boundary line between the province of Ontario and Quebec, in the township of Nepean. The farm when purchased, was largely in a virgin condition, and had to be cleared of a great quantity of stumps and stones, and much grading, draining, etc. done. An experimental farm for the maritime provinces was selected at Nappan, Nova Scotia, consisting of 302 acres. Wm. Saunders is director of the station, F. T. Shutt, chemist, Jas. Fletcher, entomologist and botanist, W. W. Hilborn, horticulturist, all residing at the central station. Thirty-two of the 57 pages of this report are by the entomologist and botanist.

The first annual report of the Texas station represents original work of importance, but largely is explanatory of organization. The following seven subjects were taken up by the station for investigation. 1, The most practical and economical method of feeding cattle for beef and dairy. 2, A study of "cotton blight" or "root-rot." 3, Testing varieties of fruits. 4, Testing grasses and forage plants. 5, Comparing effect of barn-yard manure and commercial fertilizers. 6, Value of tile drainage for crops. 7, Disinfection and inoculation of cattle to protect from Texas fever. However, the character of the work published in this report, speaks well for the efforts being made by this station. The most important paper in the report is upon root-rot of cotton, by Prof. L. H. Pammel, an abstract from which we have already published. A series of experiments to show the effects of fertilizers on sweet potatoes is recorded, but the results are rather unsatisfactory.

Meteorological tables, to accompany garden notes and other reports of field observations, from May to November, furnish the material for bulletin six of the Dakota station. Bulletin seven of the same institution records the success attending the growth of different varieties of trees, shrubs and garden plants at the college. Such bulletins as these best explain their value inthe following quotation: "Two varieties, the dwarf and dwarf white fruited, were received from Bottineau county where both are native. Unfortunately the plants were not well rooted, and only three grew. These made but one or two inches of wood, so that it is hardly fair to judge them." It is exceedingly unfortunate that stations should feel compelled to publish such material, which only represents the formative stage of an experiment.

The following item, from the *North British agriculturist* (April 3) is of interest. In order to provide for the carrying on of experimental work at Rothamsted, Sir John B. Lawes proposes eventually to place the sum of $500,000 in the hands of three trustees to be named by him. They will have a lease granted to them of the laboratory and lands on which the experiments are at present being conducted, and will also have power to purchase lands for the purpose of the trust. The trustees are to pay over the income of the fund to a committee of nine persons, viz.:—four fellows of the Royal society; one fellow of the Linnean society; two members of the Royal agricultural society; one fellow of the chemical society, and one, the owner of Rothamsted for the time being. These will be appointed for five years each, but may be reappointed. The committee will have the sole management, superintendence and direction of the institution and of the laboratory at Rothamsted, and are to devote the income of the trust to scientific investigation and experiments connected with agriculture, including animal and vegetable physiology, meteorology, botany, chemistry, etc., but their object is confined to original investigation, with a view to advancing agricultural science.

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# SHORT'S METHOD FOR LABORATORY PURPOSES. MILK ANALYSIS BY CALCULATION.

BY F. W. A. WOLL.

Among the numerous methods which have been proposed from time to time for the purpose of determining fat in milk, only a few are at the present time in general use. Last year a new method was published from this station, known as Short's method; it has already been tried and adopted by many parties, and bids fair to become an important factor in progressive dairying in this and other countries. The method was intended and especially adapted for dairy farmers; to aid them in judging about the quality of the milk given by each individual cow in the herd, and thus enable them to "weed out" the ones that on account of small fat content in their milk or a small milk yield proved not to come up to a certain chosen standard.

The features of the method are as follows[1]: 20 c. c. of milk are heated with an alkali solution for a couple of hours; the soap is decomposed by a mixture of sulfuric and acetic acids, again heated, and the layer of insoluble fatty acids is forced into the upper narrow neck of the testing tubes used, by the addition of hot water, and is there measured off directly.

Comparisons between this method and standard gravimetric methods, made in the laboratory of this station, and elsewhere, showed the method to have a high degree of accuracy. The average of forty-one analyses of all kinds of milk was:

| | | |
|---|---|---|
| By gravimetric method, | 4.31 | per cent. of fat. |
| " Short's method, | 4.33 | " " " " |

Twelve analyses of herd milk made by the farm superintendent of this station gave 4.422 per cent. of fat, by Short's method, and 4.424 per cent. by gravimetric analysis[2].

While the method primarily is a practical method, for the use of persons not in possession of the facilities offered in a chemical laboratory, the close agreement between the results found in this way and by gravimetric analyses, makes it of value to the agricultural chemist as well. This latter point, the adaptability of the method for laboratory purposes, we shall consider in the following.

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[1] For detailed description of the method, see fifth annual report, Wis. agr'l exp. station, 1888, pp. 124-136.

[2] For further comparative analyses, see fifth annual report, Wis. agr'l exp. station, 1888, pp. 133-134; and bulletin No. 19, page 13, U. S. dep't of agr., division of chemistry.

Especially in the case of feeding and digestion experiments, where daily analyses of the milk from several cows have to be made for a length of time, it would be a source of great relief and saving of time, if a short, easy method like this could be employed. As a rule, the percentages of total solids and fat and the specific gravity of the milk for every day are wanted in such experiments. Short's method gives only the percentage of fat in the milk. By combining this with the determination of specific gravity of the milk, it was thought that satisfactory results would be obtained for the total solids in the milk, and that thus regular chemical analysis might be avoided.

To test this question the writer made daily analyses by both methods, of the milk from two cows during a digestion experiment, conducted at this station from February 14 to March 27, this year. The percentages of solids and fat in the milk were determined daily by gravimetric analyses (essentially Babcock's method[1]). The specific gravity of the milk was determined by a Westphal balance; the temperature usually was about 20° C., the determinations were corrected for 15° C.[2] The tubes for the determinations by Short's method were furnished by Emil Greiner, New York city; the necks of the tubes were graduated so that the percentage of fat might be read off directly.

The experiment was conducted for the purpose of determining the digestibility of fodder corn and corresponding ensilage. It will be reported on fully at a later date in connection with other experimental work at this station during the last season. Only the data in connection with Short's method will be touched upon here.

The two cows of the experiment were: Bessie, grade Jersey, 81 days from calving at the beginning of the experiment, and Bunn, cross-bred Holstein and Jersey, 87 days from calving, at the beginning of the experiment. Samples from evening's and morning's milking were united, and the mixed samples analyzed. The feed was, Smedley flint fodder corn, February 14–26; Smedley flint corn ensilage, February 27–March 13; Smedley flint fodder corn, March, 14–27; in case of Bessie, ten pounds of wheat bran were fed in addition to the fodder corn during the last week of the experiment, March 14–20. Only single determinations were made, except from March 19–27, when duplicate analyses were made of Bunn's milk.

We shall first consider the comparative results of the analyses according to the gravimetric and Short's method. The following are the detailed results of the daily analyses of the samples of milk.

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[1] Bulletin No. 19, U. S. department of agr., division of chemistry, page 81; also AGR'L SCIENCE, vol. ii, page 228.

[2] Martiny; Die Milch, pp. 156–7.

## ANALYSES OF SAMPLES OF MILK.

| Date. | Bessie. | | | | Bunn. | | | |
|---|---|---|---|---|---|---|---|---|
| | | Fat. | | | | Fat. | | |
| | Solids. | Gravimetric. | Short's method. | Sp. gr. (15° C.) | Solids. | Gravimetric. | Short's m'th'd. | Sp. gr. (15° C.) |
| | per ct. | per ct. | per ct. | | per ct. | per ct. | per ct. | |
| *Period I.* | | | | | | | | |
| Feb. 14 | 13.66 | 5.18 | 5.30 | 1.031 | 11.69 | 3.74 | 3.60 | 1.029 |
| " 15 | 13.28 | 5.03 | 5.10 | 1.031 | 11.76 | 3.55 | 3.50 | 1.029 |
| " 16 | 12.77 | 4.27 | 4.20 | 1.032 | 11.30 | 3.13 | 3.20 | 1.029 |
| " 17 | 12.35 | 3.82 | 3.80 | 1.033 | 10.97 | 2.96 | 2.85 | 1.029 |
| " 18 | 12.86 | 4.29 | 4.30 | 1.032 | 11.24 | 3.16 | 3.00 | 1.029 |
| " 19 | 12.54 | 4.05 | 4.00 | 1.033 | 10.76 | 2.98 | 2.90 | 1.029 |
| " 20 | 13.24 | 4.85 | 4.84 | 1.032 | 10.96 | 3.04 | 3.00 | 1.030 |
| Average, week 1, | 12.96 | 4.50 | 4.51 | 1.0320 | 11.24 | 3.22 | 3.15 | 1.0291 |
| Feb. 21 | 13.51 | 4.90 | 5.02 | 1.029 | 10.94 | 2.96 | 3.06 | 1.028 |
| " 22 | 13.06 | 4.46 | 4.50 | 1.032 | 11.27 | 3.14 | 3.00 | 1.031 |
| " 23 | 13.26 | 4.64 | 4.70 | 1.032 | 11.31 | 3.16 | 3.00 | 1.031 |
| " 24 | 13.37 | 4.71 | 4.70 | 1.033 | 11.32 | 3.09 | 2.90 | 1.031 |
| " 25 | 13.03 | 4.47 | 4.50 | 1.033 | 11.21 | 3.27 | 3.06 | 1.034 |
| " 26 | 13.58 | 5.09 | 5.02 | 1.031 | 11.20 | 3.18 | 3.16 | 1.029 |
| Average, week 2, | 13.30 | 4.71 | 4.74 | 1.0317 | 11.21 | 3.13 | 3.03 | 1.0307 |
| *Period II.* | | | | | | | | |
| Feb. 27 | 13.17 | 4.74 | 4.60 | 1.029 | 11.35 | —— | 3.20 | 1.029 |
| " 28 | 12.57 | 4.42 | 4.60 | 1.031 | 10.83 | 3.14 | 3.04 | 1.028 |
| Mar. 1 | 12.55 | 4.18 | 4.10 | 1.033 | 11.26 | 3.20 | 3.06 | 1.029 |
| " 2 | 13.04 | 4.49 | 4.50 | 1.029 | 11.59 | 3.30 | 3.10 | 1.033 |
| " 3 | 11.79 | 3.57 | 3.40 | 1.029 | 10.89 | 2.90 | 2.70 | 1.028 |
| " 4 | 12.00 | 3.84 | 3.68 | 1.033 | 11.15 | 3.32 | 3.05 | 1.029 |
| " 5 | 12.15 | 4.16 | 4.10 | 1.033 | 11.08 | 3.15 | 3.10 | 1.030 |
| " 6 | 13.13 | 4.69 | 4.80 | 1.031 | 10.91 | 3.08 | 3.00 | 1.029 |
| Average, week 1, | 12.55 | 4.26 | 4.22 | 1.0308 | 11.13 | 3.16 | 3.01 | 1.0293 |
| Mar. 7 | 12.73 | 4.42 | 4.40 | 1.029 | 11.33 | 3.43 | 3.32 | 1.027 |
| " 8 | 12.93 | 4.61 | 4.56 | 1.035 | 11.19 | 3.34 | 3.24 | 1.032 |
| " 9 | 13.46 | 5.10 | 5.00 | 1.032 | 10.64 | 2.98 | 2.84 | 1.030 |
| " 10 | 12.54 | 4.25 | 4.16 | 1.029 | 11.00 | 3.09 | 2.76 | 1.029 |
| " 11 | 12.40 | 3.93 | —— | 1.032 | 11.06 | 2.97 | 2.75 | 1.029 |
| " 12 | 12.28 | 4.19 | 4.00 | 1.028 | 10.67 | 2.77 | 2.60 | 1.031 |
| " 13 | 12.06 | 3.96 | 3.80 | 1.035 | 10.40 | 2.71 | 2.58 | 1.034 |
| Average, week 2. | 12.63 | 4.35 | 4.32 | 1.0314 | 10.90 | 3.04 | 2.87 | 1.0303 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| *Period III.* | | | | | | | | |
| Mar. 14 | 12.28 | 3.99 | 3.86 | 1.034 | 11.16 | 3.24 | 3.10 | 1.031 |
| " 15 | 13.37 | 4.83 | 4.80 | 1.033 | 11.81 | 3.09 | 2.80 | 1.029 |
| " 16 | 13.76 | 5.23 | 5.10 | 1.031 | 11.16 | 3.13 | 2.90 | 1.029 |
| " 17 | 13.50 | 5.07 | 5.00 | 1.034 | 11.24 | 3.17 | 2.92 | 1.031 |
| " 18 | 13.19 | 4.67 | 4.48 | 1.033 | 11.09 | 3.21 | 2.90 | 1.028 |
| " 19 | | | | | 11.08 | 3.23 | 3.12 | 1.029 |
| " 20 | | | | | 11.34 | 3.25 | 3.16 | 1.034 |
| Average, week 1, | 13.22 | 4.76 | 4.65 | 1.0330 | 11.13 | 3.19 | 2.96 | 1.0301 |
| Mar. 21 | | | | | 10.70 | 2.98 | 2.85 | 1.032 |
| " 22 | | | | | 11.40 | 3.60 | 3.45 | 1.030 |
| " 23 | | | | | 10.65 | 2.97 | 3.01 | 1.032 |
| " 24 | | | | | 11.52 | 3.36 | 3.13 | 1.033 |
| " 25 | | | | | 11.07 | 3.19 | 3.08 | 1.031 |
| " 26 | | | | | 11.14 | 3.05 | 2.82 | 1.034 |
| " 27 | | | | | 10.52 | 2.95 | 2.80 | 1.030 |
| Average, week 2, | | | | | 11.00 | 3.16 | 3.02 | 1.0317 |

If we take the average of the whole series of determinations we get the following figures:

| | Bessie. | Bunn. |
|---|---|---|
| Gravimetric analysis | 4.52 per cent fat. | 3.15 per cent. fat. |
| Short's method | 4.49 " " | 3.01 " " |

It will be noticed that in case of the cow Bessie, the analyses by the two methods agree very well; occasionally the results come .2 per cent. apart, but usually the difference is within one-tenth of one per cent. On the whole, the analyses may be said to come out satisfactorily. The cow Bunn, on the other hand, gives constantly too low results with Short's method, although even in this case they are near enough to the gravimetric analyses for all practical purposes. In trying to explain this it will be necessary to consider the formula from which the results are calculated in Short's method.

If X = the percentage of fat in the milk, then we have

$$X = \frac{a \times b \times c}{d \times e} \times 100.$$

Where a = the length of the column of fat in millimeter.
b = the value of one linear millimeter of measured fat.
c = the specific gravity of the insoluble fatty acids.
d = the sp. gr. of the milk multiplied by the volume of milk taken.
e = the percentage of insoluble fatty acids in the fat.

Taking for granted that the calibration of the tubes is correct, we have the result of the analyses depending upon the following three factors: The specific gravity of the insoluble fatty acids, and of the milk, and the percentage of insoluble fatty acids in the fat. In the calculation of the formula, the first factor has been assumed to be 0.914; the sp. gr. of the milk = 1.032, and the per cent. of insoluble fatty acids = 87. One point must here be remembered: the column of fatty acids measured is not exclusively insoluble fatty acids, but a mixture of soluble and insoluble acids, which very likely will differ somewhat with different kinds of milk; the column will also contain small quantities of water.

The higher the specific gravity of the milk analyzed is, the lower the result of the analysis will come; if, therefore, the assumed sp. gr. of the milk is too high, the per cent. of fat will be correspondingly low, and vice versa. In the same way, the per cent. of the fatty acids in the fat stands in inverse proportion to the per cent. of fat in the milk. If, e. g., the fat of the milk contains only 85.6 per cent. of insoluble fatty acids, the result of the analysis by Short's method, having been calculated for 87 per cent., will be $\frac{87}{85.6}$ too low. The sp. gr. of the milk can be readily ascertained; the determination of insoluble fatty acids in the fat (butter fat) is more difficult, but can be made by churning some of the milk, melting the butter, filtering and analyzing the fat according to Hehner's method[1].

The specific gravity of the insoluble fatty acids, as they are measured in the neck of the tubes, is more difficult to determine; the temperature at which they are measured ought to be from 70–80° C. The specific gravities of the components of the mixture have been found: for palmitic acid (compared with water at 4° C.), $d_{62}=0.8527$ (Krafft); stearic acid, between nine degrees and 11 degrees, equal to that of water (Kopp); oleic acid, $d_{19}=0.898$ (Chevreul).

Allen gives a table of the specific gravity of insoluble fatty acids from various sources, determined at 15.5° C., and 98–99° C.[2] At the latter temperature, the densities vary from .835 to .896.

It would seem, therefore, that the value for the sp. gr. of the insoluble fatty acids in the formula, .914, is too high. A lower value, about .850 would be more correct.* In case of Bessie's milk, the errors introduced by this high value of *c* have been nearly balanced by the other factors *d* and *e*, while with Bunn's milk this is not the case.

It must be remembered that the formula is very largely an empirical one. The deviation between gravimetric analyses and analyses by Short's method, will be pretty constant for milk from each individual cow; a couple of gravimetric determinations of fat would give a correction that would bring the result of the analysis by this method almost within the limits of the error of analysis. In case of mixed milk, herd milk, market milk, etc., the percentage of fat found by Short's method may be taken directly as the true percentage.

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*A single determination of the sp. gr. of insoluble fatty acids obtained in Short's method, gave the result .8616 at 72° C.

[1] Blyth: Foods, 1882, pp. 297–300.

[2] Commercial organic analysis, II, 1886, page 215.

### PROBABLE ERROR OF ANALYSIS.

In order to ascertain the accuracy of the calibration of tubes, and of the method generally, eleven determinations of three different samples were made; a rather poor milk, an average milk, and a very rich milk were chosen.

The following are the results of the determinations. Only the percentages are here given. To eliminate the personal equation, readings were made both by Dr. Babcock and by the writer. The figures in the first column are those of Dr. Babcock's, in the second my own. The readings in both cases were made entirely independently.

| Milk of Bunn, March 27, 5 A. M. | | | Herd milk, April 2, 5 A. M. | | | Milk of Sylvia, March 30, 5 A. M. | | |
|---|---|---|---|---|---|---|---|---|
| No. of tube. | I | II | No. of tube. | I | II | No. of tube. | I | II |
| | p. ct. | p. ct. | | p. ct. | p. ct. | | p. ct. | p. ct. |
| 50 | 2.60 | 2.60 | 2 | 3.90 | 3.84 | 50 | 6.80 | 6.90 |
| 46 | 2.60 | 2.60 | 29 | 4.00 | 3.90 | 46 | 6.90 | 6.84 |
| 17 | 2.60 | 2.60 | 50 | 3.90 | 3.80 | 17 | 7.10 | 7.10 |
| 29 | 2.60 | 2.60 | 46 | 3.90 | 3.90 | 29 | 6.90 | 6.90 |
| 53 | 2.60 | 2.60 | 7 | 3.90 | 3.96 | 53 | 6.90 | 6.96 |
| 61 | 2.60 | 2.60 | 53 | 3.90 | 3.90 | 61 | 7.00 | 7.00 |
| 2 | 2.70 | 2.70 | 61 | 4.00 | 3.90 | 2 | 7.00 | 6.96 |
| 32 | 2.52 | 2.58 | 52 | 3.80 | 3.80 | 32 | 6.86 | 6.90 |
| 39 | 2.54 | 2.70 | 62 | 3.90 | 3.84 | 39 | 6.80 | 6.80 |
| 7 | 2.64 | 2.60 | 39 | 3.90 | 3.80 | 7 | 6.90 | 7.00 |
| 14 | 2.58 | 2.60 | 17 | 4.00 | 4.00 | 14 | 7.00 | 7.00 |
| Averages. | 2.60 | 2.62 | Averages. | 3.92 | 3.88 | Averages. | 6.92 | 6.94 |

The results, as will be seen, agree remarkably well; the greatest difference between the determination of fat in the same milk is found in case of the very rich milk from Sylvia, amounting to .30 per cent.; in the other samples the maximum variation is .18 per cent. and .20 per cent., in case of Bunn's milk, and the herd milk, respectively.

Considering the average error of a single determination we have, according to the formulas:

$$\text{average error} = \sqrt{\frac{S}{n-1}}$$

$$\text{and probable error} = \tfrac{2}{3}\sqrt{\frac{S}{n-1}}$$

where S = the sum of the square differences between average and each single determination, and n = number of determinations:

ERRORS OF ANALYSES.

| | Bunn's milk 2.60 p. ct. fat. | | Herd milk 3.92 p. ct. fat. | | Sylvia's milk 6.92 p. ct. fat. | |
|---|---|---|---|---|---|---|
| | I. | II. | I. | II. | I. | II. |
| | per. ct. | per. ct. | per. ct. | per. ct. | per ct. | per. ct. |
| Average error... | .047 | .042 | .060 | .067 | .098 | .085 |
| Probable error... | .031 | .028 | .040 | .045 | .065 | .057 |

As would be naturally supposed the probable error of a single determination is larger in case of a rich milk than of a poor milk.

In all cases the probable error is very small, in fact no larger than found in case of gravimetric determination of fat in milk, by the extraction method, made by the writer.[1]

The above errors of analysis naturally only refer to this method considered by itself; they tell nothing about the absolute correctness of the analyses. This point has been considered in the preceding.

ADDITIONAL COMPARATIVE ANALYSES.

The following analyses of the milk from the herd of Mr. M. E. Moore, Cameron, Mo. were made by the writer and are given here, as they throw more light on the value of the method under discussion. The analyses were all made in duplicate. The milk was from full-blooded Holstein cows.

| Name of Cow. | Milking. | Solids. | Fat. | | Sp. Gr. corrected to 15° C. |
|---|---|---|---|---|---|
| | | | Gravimetric. | Short's m'th'd | |
| | | Per cent. | Per cent. | Per cent. | Per cent. |
| Gerben Fourth.. | Noon, Feb. 17 | 13.96 | 4.91 | 4.89 | 1.033 |
| " " | 6 P. M., Feb. 17 | 13.10 | 3.86 | 3.80 | 1.034 |
| " " | 6 A. M., Feb. 18 | 12.69 | 3.53 | 3.43 | 1.034 |
| Emp. Josephine | Noon, Feb. 17 | 12.89 | 4.00 | 4.05 | 1.034 |
| " " | 6. P. M., Feb. 17 | 12.78 | 3.67 | 3.70 | 1.034 |
| " " | 6 A. M., Feb. 18 | 12.27 | 3.01 | 3.15 | 1.034 |
| Lady St. Anna | Noon, Feb. 17 | 12.25 | 3.71 | 3.90 | 1.032 |
| " " | 6 P. M., Feb. 17 | 11.90 | 3.03 | 3 20 | 1.034 |
| " " | 6 A. M., Feb. 18 | 11.54 | 2.94 | 3.05 | 1.032 |
| Josephine, 2d | 6 A. M., Feb. 18 | 13.79 | 4.58 | 4.80 | 1.033 |
| Josephine, 3d | 6 A. M., Feb. 18 | 12.66 | 3.74 | 3.90 | 1.034 |
| Average | | | 3.73 | 3 81 | |

NOTES ON SHORT'S METHOD.

In the preceding, the method has been discussed, especially from the stand-point of the agricultural chemist; the main advantage which is derived from its adoption in the laboratory is a great saving of time. It takes from three to four hours to finish an analysis by this method; and it does not take much longer time with a large number of samples than with a small number. At the present writing, one of the chemists of this station has been analyzing from twenty to twenty-four samples of milk every day for two weeks, and the results of each day's analysis have been in at about two o'clock every afternoon. Those familiar with milk analysis will know that gravimetric analyses of such a large number of samples would tax the time of the chemist to the utmost, and the result as far as the fat content of the sample of milk goes, would not be in until the following day at the earliest.

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[1] Errors of analysis, III Ann. report, Wis. agr'l exp. station, 1885, page 138; see also Martiny, Die Milch, I, page 140.

Up to the present date more than one thousand analyses according to Short's method have been made in this laboratory. The experience gained in working the method may therefore be of value to others; hence a few hints on its operation.

In the beginning great difficulty was experienced in the breaking of the tubes. The tubes in use at the present time (about 2 dozen) have stood the repeated heating and cooling, without the breaking of a single tube, for more than 200 determinations. Precautions are taken never to put cold tubes in boiler containing hot water; nor to put the warm tubes from boiler down on a cold table; a little caution in this way will remove the danger of cracking tubes.

Difficulty is sometimes experienced in getting a clear separation; flecks of undecomposed casein will gather on the top, in the layer of fatty acid itself or directly under it, so as to make reading uncertain or impossible. Leaving the tubes to cool off, and then reheating will often clear the layer; the better way is to keep the tubes perfectly clean all the time, and the danger of these flecks gathering in the neck will be greatly lessened. As soon as a determination has been made the tubes ought to be emptied and cleaned; use a small brush to clean the neck from any foreign particles, and wash the tubes with a little hot water. The tubes are very easily cleaned while hot; the whole process of cleaning then does not, by far, take the time which is required later when the tubes are cold. An excess of acid will be found to facilitate the solution of the flocks of casein.

In adding the water after having heated with acid, the following procedure is followed; the tubes are filled carefully with hot water up to the beginning of the narrow tubes, then left standing for a minute or two, and more hot water is then added by means of a pipette till the layer of fat is within the scale on the neck. Worked in this way the layer of fat is separated from the layer of brown liquid below by a clear layer of water, and the reading can be made very accurately. The measurement of the layer of fatty acids will be dependent to a certain extent upon the temperature of the water in the boiler. This ought to be hot, but not boiling. About 80° has been the temperature in our determinations. The tubes can be read off after about one hour from the addition of water. After this time the height of the layer will be constant. If read before, the per cent. of fat will be too high, on account of the excess of water in the layer.

### RELATIONS BETWEEN SOLIDS, FAT, AND SPECIFIC GRAVITY.

In the former part of this paper were given the results of daily analyses of samples of milk, according to the gravimetric chemical method, and Short's method. It was supposed that the data obtained from the latter method, in connection with the sp. gr. test would give results for the total solids in the milk, by application of well-known formulas, that would correspond fairly well with those found by chemical analysis. This, however, proved not to be the case. The percentages of total solids calculated in this way, by any of the formulas given, varied considerably from the actual percentages. As an example, the first week's test of Bessie's milk will be given. The formulas used were those of Dr. Fleischmann (I),[1] and of Hehner & Richmond (II).[2]

I. total solids$= 1.2\times$fat$+2.665\,\frac{d}{s}$

II. fat$=.859\times$total solids$-.2182s-.05\left(\frac{s}{\text{total solids}}-2.5\right)$ in which $d= 100\times s - s$, and s= specific gravity.

MILK FROM BESSIE, PERIOD I, FIRST WEEK.

| Sp. gr. (corrected for 15°. C) | Fat. (Short's method.) | Total Solids in per cent. | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Calculated. | | | |
| | | Found. | I. | Difference. | II. | Difference. |
| | per ct. | | | | | |
| 1.031 | 5.30 | 13.66 | 14.37 | +.71 | 14.05 | +.39 |
| 31 | 5.10 | 13.28 | 14.13 | +.85 | 13.81 | +.53 |
| 32 | 4.20 | 12.77 | 13.30 | +.53 | 13.01 | +.24 |
| 33 | 3.80 | 12.35 | 13.07 | +.72 | 12.81 | +.46 |
| 32 | 4.30 | 12.86 | 13.42 | +.56 | 13.13 | +.27 |
| 33 | 4.00 | 12.54 | 13.31 | +.77 | 13.03 | +.47 |
| 32 | 4.84 | 13.24 | 14.07 | +.83 | 13.76 | +.52 |
| Average. | | | | .71 | | .41 |

For the other cow, Bunn, the results of the first week's analyses were as follows:

MILK FROM BUNN,—PERIOD I, FIRST WEEK.

| Sp. gr. (corrected for 15° C.) | Fat. (Short's method.) | Total Solids in per cent. | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| | | | Calculated. | | | |
| | | Found. | I. | Difference. | II. | Difference. |
| | per cent. | | | | | |
| 1.029 | 3.60 | 11.69 | 11.83 | +.14 | 11.56 | —.13 |
| 29 | 3.50 | 11.76 | 11.71 | —.05 | 11.44 | —.32 |
| 29 | 3.20 | 11.30 | 11.35 | —.05 | 11.09 | —.21 |
| 29 | 2.85 | 10.97 | 10.93 | +.04 | 10.70 | —.27 |
| 29 | 3.00 | 11.24 | 11.01 | —.23 | 11.00 | —.24 |
| 29 | 2.90 | 10.76 | 10.99 | +.23 | 10.76 | .00 |
| 30 | 3.00 | 10.96 | 11.36 | +.40 | 11.12 | +.16 |
| Average. | | | | .16 | | .19 |

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[1] *Journal f. Landwirthschaft*, 1885, 251. [2] *The analyst*, London, vol. XIII, 26.

These results can hardly be said to be satisfactory; the greatest difference between the calculated and the determined percentage of total solids is .85 per cent. with Fleischmann's formula, and .53 per cent. with Hehner's formula. In case of the milk from Bessie the results always come too high, while in case of Bunn's milk they come nearer the actual per cent. of solids. The reason for this is, as we have seen, that the fat determinations with Short's method come too low with her milk, and the per cent. of solids calculated will be correspondingly low.

In the following table will be found the weekly averages for the sp. gr., solids and fat for the two cows; from the data for fat, and sp. gr., the percentages of total solids are calculated from the formulas already given.

BESSIE.

| | Sp. gr. (Corrected for 15°). | Fat. (Short's method.) | Total solids in per cent. | | | | |
|---|---|---|---|---|---|---|---|
| | | | Found. | Calculated. | | | |
| | | | | I | Diff. | II. | Diff. |
| | | p. ct. | | | | | |
| Period I, First week. | 1.0320 | 4.51 | 12.96 | 13.67 | +.71 | 13.37 | + 41 |
| " I, Second " | 1.0317 | 4.74 | 13.30 | 13.87 | +.57 | 13.47 | +.17 |
| Period II, First week. | 1.0308 | 4.22 | 12.55 | 13.03 | +.48 | 12.58 | +.03 |
| " II, Second " | 1.0314 | 4.32 | 12.63 | 13.30 | +.67 | 12.80 | +.17 |
| Period III, First w'ek. | 1.0330 | 4.65 | 13.22 | 14.09 | +.87 | 13.80 | +.58 |
| Average ............ | | | | - | .66 | | .27 |

BUNN.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Period I, First week. | 1.0291 | 3.15 | 11.24 | 11.31 | +.07 | 11.01 | — 23 |
| " I, Second " | 1.0307 | 3.03 | 11.21 | 11.57 | +.36 | 11.24 | +.03 |
| Period II, First we'k. | 1.0293 | 3.01 | 11.13 | 11.20 | +.07 | 10.70 | —.43 |
| " II, Second " | 1.0303 | 2.87 | 10.90 | 11.28 | +.38 | 10.89 | —.01 |
| Period III, First w'ek. | 1.0301 | 2.96 | 11.13 | 11.34 | +.21 | 11.06 | —.07 |
| " III, Second " | 1.0317 | 3.02 | 11.00 | 11.81 | +.81 | 11.48 | +.48 |
| Average ............ | | | | | .32 | | .21 |

Hehner's formula is based upon the Adams' method of fat analysis, and the author claims nothing for it outside of this method. It was tried, however, in the hope that it would give satisfactory results also in case of fat determinations by Short's method.

These results naturally led to an investigation of the question of milk analysis by calculation. The first attempt to determine the fat or solids in milk from one of the components in connection with the specific gravity, was, I believe, made in 1879 by Behrend and Morgen.[1]

They give tables for the calculation of solids in percentages by volume and by weight, from fat and specific gravity. Clausnitzer and A. Mayer[2] in the same year published another formula on basis of the assumption that every percentage of solids not fat raises the sp. gr. .00375, while every per cent. of fat lowers the sp. gr. .0010; the following is the formula:

$$\text{fat} = \frac{\text{solids} \times .00375 + 1 - \text{sp.gr.}}{.00475}$$

In 1882 Fleischmann and Morgen published the following formula[3]:

$$\text{solids} = \text{fat} \times 1.173 + 2.71 \left(100 - \frac{100}{\text{sp. gr.}}\right)$$

which formula Dr. Fleischmann[4] later modified after having made thorough investigations in regard to the constants used in the formula. The new formula published in 1885 is the one already given on p. 137.

O. Hehner[5] in 1882 worked out a formula for determination of fat, based on the sp. gr. test and total solids according to the Wanklyn process, and gave tables giving the relation between solids, fat and sp. gr.

His formula was:

$$\text{fat} = .8325 \times \text{solids} - .231 \times \text{sp. gr.}$$

Halenke and Moeslinger[6] in 1886 published the following formula for the calculation of fat from solids and sp. gr., being Clausnitzer and Mayer's formula modified.

$$\text{fat} = \text{solids} \times 0.8 - \frac{\text{sp. gr.} - 1}{0.005}$$

Finally, in 1888, Hehner and Richmond[7] worked out a formula on the basis of the Adams' coil extraction method. This formula has been given above.

Of all these formulas proposed, those of Dr. Fleischmann and Hehner & Richmond are the most promising ones. Fleischmann's formula has been discussed by various writers, several of whom have testified to the accuracy of the results obtained by their application. The formula was substantiated by the author by a series of analyses that all agreed very well. The greatest deviation from the result found by analyses was two-tenths of one per cent., while the average deviation was only .0044 per cent. Caldwell[8] discusses this formula in a paper read before the Society for the promotion of agr'l science, and applies the formula to older analyses made by Dr. Fleischmann. In case of four analyses taken at random, the differences between the determined and the calculated result for total solids were .031, .49, .22 and .66 per cent. The older formula of Dr. Fleischmann's gave better results; still, however, the differences were so great as to forbid the use of the formulas in scientific work.

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[1] *Journal für Landwirthschaft*, xxvii, 249.

[2] *Forschungen auf d. Gebiete d. Vieh-haltung*, 1879, 265.

[3] *Journal für Landwirthschaft*, xxx, 293.

[4] Ibid., xxxiii, 251.

[5] *Analyst*, vii, 129.

[6] *Chem. Zeit.*, 1886, 8: abstr. in Jahresb. Agr. Chemie, 1886, 598.

[7] *Analyst*, xiii, 26.

[8] Proceedings soc. prom. agr'l science, 1886, page 20.

This criticism excepted, it seems to be a pretty generally accepted view that these formulas give reliable results, as appears from the following quotations. Vieth[1] says "of all these formulas, those worked out by Professor Fleischmann are, no doubt, the most useful and correct ones. . This single determination (the sp. gr. test)—in conjunction with either the determination of fat by means of one of the centrifugal apparatus, or of Soxhlet's areometric process, which can be carried out almost anywhere; or of the total solids, which will be found rather less suitable and convenient for general use—is sufficient to give every information with regard to the composition of milk which is required under ordinary circumstances." Bell[2] takes a more conservative view: "the theoretical results which are calculated from even the modified formula proposed by Hehner, are in most instances too high in the non-fatty solids, and to the same extent too low in the fat; but the amounts are sufficiently near accuracy, especially in case of samples of average quality, to be useful where the adoption of a quick and ready method of milk analysis is a desideratum. In cases, however, where unquestionable accuracy is required the variations from the true percentages, as given by this method, are a fatal objection to their use." Dammer[3] states that, knowing the sp. gr. and the fat or total solids, either of these latter two can be determined with an accuracy of 0.1 per cent. by Fleischmann's formula.

Wiley[4] after giving the formula for calculation of solids or fat, says, "by these formula whenever the per cent. of fat or the total solids is known, the other can be calculated with a high degree of accuracy."

In the same government bulletin Dr. Wiley[5] gives the results of analysis of milk made in the laboratory of the department of agriculture. Below are given the first ten analyses where both fat and solids were determined, taken from table No. 14, with the per cent. of solids calculated according to Fleischmann's and Hehner's formulas. The samples were from a private herd.

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[1] Easy methods for the examination of milk, 1887, page 30.
[2] Bell: Chemistry of foods, 1883, page 11.
[3] Lexicon der Verfaelschungen, 1887, page 583.
[4] Bulletin No. 13, 1, p. 100, div. of chemistry U. S. department of agriculture.
[5] loc. cit., p. 115.

## ANALYSES OF SAMPLES OF MILK.

| No. | Sp. gr. at 15 C. | Fat areometric. | Total solids in per cent. | | | | |
|---|---|---|---|---|---|---|---|
| | | | | Calculated. | | | |
| | | | Found. | I. | Difference. | II. | Difference. |
| 3 | 1.0333 | 3.64 p. ct. | 12.38 | 12.95 | + .57 | 12.54 | + .16 |
| 6 | 316 | 3.92 " | 12.92 | 12.87 | — .05 | 12.55 | — .37 |
| 8 | 362 | 3.21 " | 12.02 | 13.16 | +1.14 | 12.34 | + .32 |
| 9 | 341 | 3.66 " | 13.03 | 13.18 | + .15 | 12.88 | — .15 |
| 10 | 333 | 3.98 " | 12.38 | 13.37 | + .99 | 12.93 | + .55 |
| 11 | 315 | 3.51 " | 12.11 | 12.35 | + .24 | 12.09 | — .02 |
| 12 | 337 | 4.25 " | 12.46 | 13.79 | +1.33 | 13.41 | + .95 |
| 13 | 334 | 4.62 " | 13.91 | 14.16 | + .25 | 13.67 | — .24 |
| 16 | 358 | 4.73 " | 15.42 | 14.89 | — .53 | 14.19 | —1.23 |
| 17 | 335 | 4.98 " | 12.16 | 14.62 | +2.46 | 14.38 | +2.22 |
| Average.......... | | | | | .77 | | .62 |

The average difference between the per cent. of solids actually found and the one calculated, amounts to .77 per cent. with Fleischmann's formula, and .62 per cent. with Hehner's formula. The greatest deviation in the former case was 2.46 per cent., and in the latter case 2.22 per cent. These results certainly do not substantiate the claim for a high degree of accuracy for the method of milk analyses by calculation

These analyses, coming out as they did, led to a further study of the value of the formulas. A large number of analyses was gone over, and calculated results for solids compared with the actual percentages determined by chemical analysis. Only the differences are here given; half a dozen or ten analyses made by the same analyst were taken. American analyses were considered first. The following table gives the condensed results; the formula used for calculation of milk solids was Dr. Fleishmann's new formula.

| Name of analyst. | No. of analyses. | Limits of differences. | Average difference. | Reference. |
|---|---|---|---|---|
| | | p. ct. | p. ct. | |
| Goessmann | 6 | +1.24 and— .69 | .45 | Mass. exp. station report, 1886, p. 30. |
| Davenport | 10 | + .06 " — .52 | .35 | 26th ann. rept. Bost. milk insp'r, '85, 14. |
| Babcock | 10 | + .18 " — .23 | .09 | N. Y. exp. sta., report, 1883, 102. |
| Wiley | 10 | + .94 " —2.23 | .52 | U. S. dept. of agr. rept., 1884, 66. |
| Woll | 10 | +1.14 " —1.34 | .62 | AGL. SCIENCE,' 88, 230.* |
| Babcock | 10 | — .05 " — .57 | .22 | N. Y. exp. sta. report, 1883, 103. |
| " | Av. of determinations made during year. | + .04 " — .22 | .13 | Ibid, p. 153. |

Having thus ascertained that Fleischmann's formula for the calculation of solids in the milk from the per cent. of fat and the specific gravity does not give satisfactory results with samples of milk analyzed in this country, the writer looked up older analyses of milk made by scientists across the ocean. The analyses were taken at random ; no analyses have been calculated except those given below. As above, the results are condensed so as to give only the limits and average of deviation.

| Name of analyst. | No. of analyses. | Limits of differences. | Average difference. | Reference. |
|---|---|---|---|---|
| | | p. ct. | p. ct. | |
| Fleischmann | 10 | +.35 and+.15 | .25 | Jahresber. ag. ch. 1880, 488. |
| " | 6 | + .02 " —.04 | .04 | Ibid, 1882, 459. |
| Kühn | 10 | + .19 " —.20 | .13 | *Journ. f. Landw.*, xxii, 194. |
| Gerber | 10 | + .01 " —.21 | .14 | *Milch Zeitung*,'89, 174. |
| Janke | 10 | +1.54 " —.20 | .35 | Ibid, '79, 9. |
| Fruehling & Schultz | 10 | + .56 " —.61 | .25 | " '79, 205. |
| Portele | 10 | + .96 " —.62 | .34 | *Landw. Vers. Stat.*, 81, 133. |
| Kirchner | 4 | + .28 " —.05 | .18 | *Milch Zeitung*, '78, 257. |

Other formulas than the one here used have also been tried, but with no better results. It will be seen that the differences between the calculated and the observed percentage of total solids in the milk are quite considerable in the majority of cases. Taking the analyses made in this country, only two of the analyses give satisfactory results ; a greater deviation than half a per cent. will hardly be allowed in a series of analyses. The results of the analyses made by German chemists come nearer together, although even here several of the analyses quoted come out unsatisfactorily. The reason of this varying agreement between calculated and determined results must be sought in difference in the working methods of the analysts. The only difference that can be traced out, is the determination of specific gravity, and the methods used for fat determination. The latter were either the extraction process or Soxhlet's areometric method. The results by either of these methods do not materially differ, however, and the source of error, therefore, must be found in the determination of the specific gravity. In most of the German analyses cited above, and in some of those made in this country, the samples of milk have been cooled down to 15° C., and the specific gravity always determined at this temperature. In case of my own work, the sp. gr. has been taken by means of a Westphal balance at whatever temperature the milk might happen to be, e. i., beween 21° and 14° (the temperature of no sample was outside of these limits), and correction has been made according to standard correction tables for sp. gr. It is hardly credible that the probable error in the determination of the sp. gr. could thus make almost worthless a formula for calculation of solids that has elsewhere proved of value and given results as closely concordant as could reasonably be expected.

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*Sp. Gr. determinations made with a Jolly spiral balance.

* * *

Since the above was written, some milk analyses have been made by the writer, to study the point touched upon above, the influence of the sp. gr. determination on the reliability of the formulas for the calculation of milk solids from fat and the sp. gr. of the milk. The milk of two cows was analyzed, gravimetrically, and according to Short's method. The specific gravity of the samples of milk was determined, as accurately as I knew how, at 15° C. by means of a sp. gr. bottle holding about 25 c.c., and also by the Westphal balance used in the experiment mentioned in the former part of the paper; the temperature of the milk, when the latter determination was made, varied from 14–20 degrees, and the data obtained were then corrected for 15° C.

### ANALYSES OF MILK FROM SINGLE COWS.

| Specific gravity at 15°. | | Fat in per cent. | | Solids in per cent. | | |
|---|---|---|---|---|---|---|
| | | | | | Calculated. | |
| Picnometer. | Westphal balance. | Gravim. | Short's method. | Found. | I. | Diff. |
| 1.0309 | 1.0303 | 6.26 | 6.25 | 15.27 | 15.50 | +.23 |
| 1.0301 | 1.0292 | 4.24 | 3.92 | 12.51 | 12.87 | +.36 |
| 1.0304 | 1.0308 | 6.20 | 6.32 | 15.56 | 15.30 | —.26 |
| 1.0282 | 1.0292 | 4.85 | 4.68 | 13.05 | 13.13 | +.08 |
| 1.0329 | 1.0326 | 5.72 | 5.80 | 15.20 | 15.35 | +.15 |
| 1.0303 | 1.0323 | 4.54 | 4.25 | 12.96 | 13.29 | +.33 |
| 1.0310 | 1.0340 | 6.25 | 6.06 | 15.52 | 15.51 | —.01 |
| 1.0288 | 1.0317 | 4.44 | 4.18 | 12.89 | 12.89 | —.00 |
| 1.0321 | 1 0303 | 6.16 | 6.20 | 15.41 | 15.68 | +.27 |
| 1.0304 | 1.0323 | 4.11 | 3.94 | 12.52 | 12.79 | +.27 |
| Avg. 1.0305 | 1.0313 | 5.30 | 5.16 | | | .20 |

A study of this table will, at least, suggest the following points: that the correction tables for the specific gravity of milk do not always correct; that, on the other hand, the sp. gr. to be of any value has to be taken at a definite temperature; that Fleischmann's formula for calculation of solids from fat and sp. gr., gives reliable results when great care is taken in the determination of the sp. gr. of the milk. This is brought out very clearly by comparing the above table with the tables given on pages 137 and 138, where no special precautions were taken for the determination of the sp. gr., although in that case as well due care was exercised to obtain reliable results.

There has been a good deal of discussion lately concerning the Westphal balance.[1]

The apparatus used in the preceding analyses was bought from C. Gerhardt, Bonn, Germany; price 45 marks; it was always adjusted before a determination was made. The differences between the results found by this apparatus and by the picnometer are very marked in a couple of places, and tend to throw discredit on the Westphal balance for determination for the sp. gr. of milk. The determinations in the two ways were made within an hour; the determination with the Westphal balance being made first, and then the milk cooled down for determination with the picnometer at 15 degrees C. Investigations in regard to the sp. gr. of milk are in progress at this station, and will be published later.

The importance of an accurate determination of the sp. gr. for the calculation of the total solids of the milk will be appreciated so much the more when it is remembered that a difference of one-thousandth in the sp. gr. makes a difference of about .25 per cent.

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[1] See recent numbers of *The analyst*, vol. xiii, 1889, pages 11, 50, 66.

in the result for the total solids; while an error of .05 per cent. in the determination of the fat (and no greater error need be introduced), only affects the result by 0.05×1.2 or .06 per cent. The unsatisfactory results given in the tables on p. 137 and 138 are very easily explained when the results of the sp. gr. determinations by the two methods given in the last table are considered. The difference of .003 in the seventh sample in the last table would make a difference of .75 per cent. in the total solids. The comparisons between the gravimetric analysis of fat and the analysis by Short's method show that in case of milk from individual cows the results may come as much as .32 per cent. too low. The necessity of making comparative gravimetric analysis in this case is therefore apparent, where the results are to be used in scientific investigations.

To summarize briefly the results or suggestions that the investigations discussed in the preceding pages may justify:

I. Short's method for the determination of fat in milk gives very satisfactory results; while primarily a practical method it may safely be used in scientific work where a large number of analyses have to be performed, and where average figures are considered, provided that in case of milk from individual cows, proper corrections are made for the variable factors, the specific gravity of the milk, and the per cent. of insoluble fatty acids in the milk-fat. This can be done simply by a few comparative gravimetric analyses.

II. The formula for the calculation of total solids in milk from the percentage of fat and the specific gravity, devised by Dr. Fleischmann, may be used to advantage, either for calculation of total solids, or as a check on the analysis,—when the specific gravity determination is made at 15 degrees C.

**Wisconsin agricultural experiment station, April, 1889.**

# EDITORIAL.

THE majority of the experiment station workers of the country are young men, or if not young in years, of limited experience in experimental agriculture. Unquestionably the character of the work done at stations will acquire a higher tone in all directions, practical as well as scientific. But the character of this work, will be largely controlled by the influences surrounding the investigator. As in all other occupations in life, so in scientific research we find men of varying degrees of ability, with the limited few at the top.

It would be well if all of these young men, whose ideas are now being moulded, whose methods of work will be largely guided by others, could be placed in working relations with investigators of high standing, scientifically and practically, who would teach them to work according to accepted progressive methods of research and practice.

There are men in stations, who are born politicians, and who do not exercise the proper influence over their fellows. The advancement of science and practice, is, with them, secondary to advancement of themselves; in other words they are not in love with their work. Their, influence is pernicious. There is another class of workers, men honest in all things, yet who do their work so carelessly and inaccurately their teaching is damaging. They mean to do well, but they are not capable.

The young man just beginning work at an experiment station, should have a worthy ambition, and look to the value of his labor for building up a reputation. He should seek to ally himself with men who engage in pains-taking, accurate research, rather than pattern after the superficial and careless, who drag down rather than elevate their co-laborers. There are extremes in all things, but one can be guided by common sense.

Finally, the experiment station that does not have available files of leading scientific and practical journals and books related to the work in hand, cannot retain for any great length of time, the services of men who are greatly interested in agricultural research away from their own fields and laboratories. If the young man will for a moment compare the work of his own station with that of others as shown in their reports and bulletins, he will very likely see wherein the stations differ in effectiveness of work. And he would do still better if he would compare the work done by American experiment stations with that emanating from those of Europe and elsewhere.

The real effectiveness and strength of the work of our agricultural experiment stations, is being largely governed for the future by the young men of to-day.

## RECENT LITERATURE.

PEACH YELLOWS: A PRELIMINARY REPORT BY ERWIN F. SMITH, B, Sc., pp. 254, plates 37, maps 9. Department of agriculture. Botanical division. Bulletin, No. 9. Section of vegetable pathology. Washington : Government, 1888.

This report is carefully prepared, and contains much that is interesting in a historical point of view, together with an extended account of the soils and the meteorological conditions of the districts in which the "yellows" occurs but, alas, we are still left in the dark as to the real cause of the disease and that we presume is the main point of interest in the eyes of agriculturists. However, to have it clearly stated that no efficient cause has, as yet, been discovered is far better than to be obliged to accept the vague hypotheses which have generally been proposed to account for the disease.

If we cannot be told the cause of the disease, we can, at least, be told what the symptoms of it are, and Mr. Smith has done well in declining to consider as the "yellows" any disease in which the leaves turn yellow and fall early and the fruit ripens imperfectly. As a matter of fact the word "yellows" is so vaguely understood by fruit-growers that those who have attempted to study the subject have sometimes been tempted to believe that there is no definite disease to be called the "yellows" but rather that the word represents an indefinite number of diseased conditions arising from various causes. As defined by Mr. Smith, the characteristics of the "yellows," in the proper sense, are; prematurely ripe and red-spotted fruit; development upon the trunk and branches of secondary, or summer shoots, always dwarfed and feeble in appearance; a marked tendency of the buds on the secondary shoots to develop the same season; during the second year a shortening of the shoot-axes and a dwarfing of the foliage which becomes yellowish or reddish-brown and curled; and a slow progress of the disease from limb to limb so that in two or three years the tree dies.

In this account which describes correctly the disease as seen in regions where it is of comparatively recent occurrence, Mr. Smith has been more happy than his predecessors. In the chapter on conditions known as supposed to favor the disease he considers the questions of non-adaptation of the peach to our climate, early autumn frosts, severe winters, excessive rain-fall, exhaustion or infertility of the soil, careless cultivation, etc. Some of the questions are easily disposed of. Others must be regarded as having more or less influence in modifying or intensifying the disease when it arises but, according to Mr. Smith, none of them can be considered to be the cause of the disease. It certainly is not true that the peach tree is not adapted to the climate of the states where our peach-culture has been carried on the greatest extent. Nor is there sufficient proof that exhaustion of the soil and careless cultivation cause the "yellows." Under such conditions the peach-crops naturally suffer, but the "yellows" is known in regions where the soil has not been exhausted and where careful cultivation is seen. Early frosts, severe winters, and excessive rainfall, conditions which are temporary and not constant, could hardly account for a state of things which is constant and progressive.

On the other hand, if we assume that the "yellows" is a contagious disease, in the proper sense, we encounter several questions which we are not yet able to answer. Why, for instance, does it happen that, in some of the maritime states, the orchards near the sea are decidedly more exempt from the "yellows" than those a short distance inland? Were the disease due to direct fungus contagion there is no reason why the two orchards so near together should not be equally affected. Again, how does it happen that in the older eastern states where, in tracts of considerable extent, peach-culture has been abandoned for a good many years, it is not now possible to revive the culture? Are we to suppose that the germ of infection, whatever it may be, still lies active for an indefinite number of years, in a soil where peach trees have not been grown? If so, the case is indeed desperate and we can not hope again to grow peaches successfully in districts where the "yellows" has once destroyed the orchards but, as it is certain that efforts will be made to re-establish orchards in previously infected places, the result will be merely to establish again centres of infection and spread the disease to as yet healthy districts, so that it will be merely a question of time when peach culture on any large scale must come to an end. If we can judge by other contagious diseases, however, by the abandonment of peach culture in a previously infected district for a number of years we ought to expect an immunity from the disease on replanting, unless some special condition arises to develop a new growth of the germ. If then it is true, as it appears to be, that in the older eastern states peach-culture cannot be revived on land which has been affected with the "yellows," it seems probable that some climatic or soil condition must be an important factor in the production of the disease even if the primary cause be due to a germ of some kind.

There is no reason to suppose that the trouble is due to insects and, if due to a fungus of any kind we are in the dark as to what the fungus is. It seems unlikely, but though not impossible, that it can be a fungus in the limited sense,—i. e. not counting bacteria as fungi,—for careful search has not revealed the presence of any fungus which can be considered adequate to cause the disease. Various fungi are found in trees affected by the "yellows" and they have been paraded before the public and made to account for the disease by those who have slight knowledge of the forms and habits of fungi. Mr. Smith is quite right in saying that none of the fungi which have been named in this connection are the cause of the disease. There is left the question whether it may not be due to some form of bacteria. On this point he contents himself with the statement that the question is still unsolved. The solution must be attended with great difficulties and what we have to fear is that, whether the disease is or is not caused by some species of bacteria, long before we have any real facts bearing on the question, we shall be deluged with crude theories and wordy speculations on the part of hasty workers. To ascertain with scientific accuracy—and nothing short of that will answer the purpose—that the disease is really due to bacteria requires a long and thorough research by trained experts, and if they are to give us anything valuable, they must be allowed plenty of time and not forced to make reports of progress. Strictly speaking, reports of progress have little value, for, until a definite result has been reached, one cannot well say how much progress has been made at any given time. Retrospect is vastly better than prospect as far as the public is concerned, and the man who has actually discovered something good has better claims on the public ear and the public purse than he who believes that he is going to do something better.

So far as it goes Mr. Smith's report is a good one but the most important and difficult part of the work of investigating the cause of the "yellows" remains still to be accomplished. The report, we are glad to say, shows rather a less tendency to dilate what is actually known and what has been done up to the present time than is the case with some other reports, but we cannot refrain on this occasion from uttering a protest against the custom of excessive publication which prevails in the agricultural department. We can only regret the proportionate amounts spent on research and the publication of the results of research. Where numerous and voluminous reports are are required we naturally find too much space devoted to historical and bibliographical matter and the real point, the result of scientific study, and the practical inferences to be drawn therefrom, have to be extracted from a large mass of extraneous material at a considerable loss of time and patience. We can hardly believe that the public estimate of the value of a research like the present would be influenced by the amount published rather than by the intrinsic merit of the research itself. Competent observers should be paid liberally but the reports had better be as short and clear as possible that they may be carefully read by many people rather than valued chiefly for the picturesque value of the colored plates and charts. The present report, we are sorry to say, contains a number of colored charts, showing the arrangement of peach trees in different orchards of Delaware and Maryland. We fail to see that these charts have any value either for the scientific or general reader at all commensurate with the money which must have been spent on them. It may be pleasing to the peach raisers of those two states to have colored charts of their orchards distributed through the country by the thousand but others will agree that the money had much better have been spent in continuing the real work of investigation. At present, there is a rage for colored maps. In subjects like meteorology they may serve a useful purpose but here the points which they illustrate can be more accurately expressed in the text and any contrivance by which people are led to avoid reading the text, on the supposition that looking at a chart will do as well, is not to be encouraged.

REPORT OF MASS. STATE AGRICULTURAL EXPERIMENT STATION, 1888, pp. 264, with numerous illustrations.

This report shows that the work of the station for 1888 had for its object the investigation of the following questions :

First, the comparative economy of the use of different cattle foods, with especial reference to (1) a comparison of the value of corn fodder, corn stover, and ensilage with that of English hay, for the production of milk ; (2) the comparison of green crops with English hay for the production of milk ; (3) the cost of a definite weight of dressed pork, the economy of different combinations of food nutrients in the rations being also considered, as well as the cost of a pound of growth at different ages.

Second ; Field experiments (1) in growing fodder corn with special articles of plant food ; (2) the influence of fertilizers on the quantity and quality of prominent fodder crops ; (3) experiments with various fodder crops, and (4) experiments with potatoes and root crops. The report also contains a paper on potato scab, and the results of the analyses of quite a variety of fertilizing materials, partly in the way of inspection and partly as a matter of general interest. There is given a serviceable compilation of the analyses of fodder articles, fruits and sugar-producing plants, made at the station.

Prominent among the results reached by the feeding experiments with cows is the showing of the great value of the corn plant as a food producing plant. It is a question whether the tests of the relative value of different fodders would not have given more pronounced results if less grain had been fed. When cows weighing a thousand pounds or less eat daily nearly ten pounds of rich grains, anything short of very marked differences in the quality and quantity of the accompanying fodders could scarcely have an apparent effect, excepting in very long feeding periods. It is also doubtful whether that part of the tabular statements which refers to the cost of milk produced with different foods has permanent value, or a value at all to be compared with the figures obtained in regard to the relation between the quantity and kind of nutrients consumed and the milk product. The market values of foods are changeable, and the only permanent basis on which to study the practice of cattle feeding is the economy of the use of material.

The data which Director Goessman has secured from his extended pig feeding experiments, are worth careful study. He shows clearly the possibility of profitable production, even with present ruling forces,—the essential conditions involved being a carefully changing diet from a narrow to a wider nutritive ratio as the animals grow older, and the sale of the product before the animals have reached 200 lbs. in weight with liberal feeding.

The field experiments with special articles of plant food teach in a striking manner the necessity of each farmer studying the needs of his own soil, as on the experimental land at Amherst, potash has a largely predominating effect.

This report is to be commended as giving a large amount of data which bear directly on practical subjects of great importance to the farmer. The most important work of 1888 is but a continuation of the work of previous years, and in this a good example is set for other stations to copy, viz.: the continued and thorough study of a few subjects. The matter presented is also systematically arranged, and is carefully elaborated, and coördinated with previous work.

W. H. JORDAN.

THE PRINCIPLES OF AGRICULTURAL PRACTICE AS AN INSTRUCTIONAL SUBJECT. By John Wrightson, M. R. A. C., F. C. S., president of the college of agriculture, Downton, etc., pp. 218, 1888, octavo, London: Chapman & Hall.

The author of this spicy little volume aims in his fourteen chapters, at the accomplishment of a special task. As examiner of long standing, in agriculture, to the science and art department in London, the writer claims to have accumulated from the answers given by his examinees, candidates for positions as farm managers, abundant evidence of narrowness and superficialty in the instruction imparted by the professed teachers of agriculture. To expose this state of affairs and to present in outline, with frequent illustration, an adequate course in agricultural study, is the assumed mission of the book. Many specimens of musty alchemistic answers are cited, as being repeatedly given to questions in practical agriculture. These are handled admirably for the edification of the student, although at times in somewhat caustic manner.

After such exposition, follows Mr. Wrightson's ideal course of instruction in agriculture. Descriptions of English soils, tillage, fertilizers and crops, with short interesting discussions on controverted questions in science and practice, make up the volume. In a subsequent publication still other subjects will be treated.

Sufficient proof is given of broad and special preparation of the writer for his work. In a style original and popular, he presents to the reader the evolution of our present doctrines in agriculture. At times the aptness of a criticism or distinction is uncertain. For example, on page 37, after taking exception to a categorical affirmative answer to the question, "are stones useful in soils, and why?" the author asserts they are, because of their insuring against ultimate soil exhaustion. By "stones" the author understands all mineral fragments from microscopic chips to land-fast boulders. A soil without "stones" would, then, hardly be conceivable and yet land fast boulders may profitably be omitted from arable fields.

The book is intended for local readers; it is not only English, but of value primarily to students in south England. The chapters on soils, treatment of soils and crops, especially, yield marks for this characterization. Whatever may be the minor defects of the book, it is notwithstanding a thoughtful and intelligent presentation of the subject. The closing chapters on general management of land are especially interesting.

C. WELLINGTON.

## PUBLICATIONS RECEIVED.

ALABAMA, Agricultural experiment station of the agricultural and mechanical college. Bulletin No. 5, April, 1889, pp. 56. Contents. Cotton, pigs, cattle, analyses, meteorology.

CANADA, Guelph, Agricultural college. Bulletin 37, April 15, pp. 6. Strawberries. Bulletin 38, April 24, pp. 5. The growth of green fodders. Bulletin 39, May 1, 1889, pp. 5. The composition of milk. Bulletin 40, May 3, pp. 6. Notes for cheese-makers for May.

COLORADO, The state agricultural college. The agricultural experiment station. Bulletin No. 7, April, 1889, pp. 23. Potatoes and sugar beets.

CORNELL UNIVERSITY, college of agriculture. Bulletin of the agricultural experiment station. V. April, 1889, pp. 20, plates 3. I. On the production of lean meat in mature animals. 2. Does heating milk affect the quality or quantity of butter.?

DAKOTA AGRICULTURAL COLLEGE AND EXPERIMENT STATION, Brookings, Dak. Bulletin No. 11, March, 1889, pp. 8. Department of agriculture. Small grain. Bulletin 14, April, pp. 6. Department of chemistry. The sugar beet.

ILLINOIS, university of, Agricultural experiment station, Champaign, Feb., 1889. Bulletin No. 4, pp. 37-139. Field experiments with corn.

INDIANA, Bulletin of the agricultural experiment station of. Purdue university. No. 22, March, 1889, pp. 16. Commercial fertilizers.

KENTUCKY AGRICULTURAL EXPERIMENT STATION, of the state college of Kentucky. Bulletin No. 18, April, 1889, pp. 14, plate I. I. Hemp experiments. II. Notes on the treatment of an old apple orchard.

KEW, Royal gardens. Bulletin of miscellaneous information, No. 29, May, 1889, pp. 111-126, plates 2. xcii, Persian zalil; xciii, Tasmanian woods; xciv, lily flowers and bulbs used as food; xcv, Pu-êrh tea; xcvi, short podded yam bean.

KINEALY, J. H. The pressure of the wind on roofs and inclined surfaces, pp. 337-342.

LOUISIANA EXPERIMENT STATION, Annual report of the north. Calhoun, La. Bulletin No. 22, pp. 290-320.

LOUISIANA, Report of the state experiment sation, Baton Rouge, for 1888. Bulletin No. 21, pp. 268-289.

MARYLAND AGRICULTURAL EXPERIMENT STATION, Bulletin No. 3 of the, December, 1888, pp. 29-47. Fodder-corn and fodder-cane.

MICHIGAN, Agricultural college of. Experiment station. Bulletin No. 44, January, 1889, pp. 29, plates 6. Department of practical agriculture. Feeding steers of different breeds.

NEW HAMPSHIRE AGRICULTURAL EXPERIMENT STATION, Hanover, N. H. Bulletin No. 7, May, 1889, pp. 16. Test of dairy apparatus.

New Jersey Agricultural Experiment Station. Bulletin No. 52, March 20, 1889, pp. 15. What are the worst weeds of New Jersey? Bull. 53, March 26, pp. 2. Prices of nitrogen, phosphoric acid and potash. Bull. 54, March 27, pp. 11. Potash as a fertilizer. Bull. 55, March 28, pp. 2. Entomological suggestions and inquiries.

Oregon Agricultural Experiment Station, Bulletin No. 2, January, 1889, pp. 13-27. Horticultural.

Stockbridge, H. E. Report of the chemist to the Hokkaido Cho., for the year ending March 31, 1888, pp. 36.

Tennessee, Bulletin of the agricultural experiment station of the university of, vol. II. January, 1889, No. 1, pp. 24. Notes on fertilizers and fertilizing materials.

Texas Agricultural Experiment Station. Bulletin No. 5, March, 1889, pp. 24. Creameries in Texas.

Wisconsin, University of. Agricultural experiment station. Bulletin No. 19, April, 1889, pp. 28. Notes on ensilage.

## ABSTRACTS.

### A NEW PEST OF FARM CROPS.

(By Allen Harker: *Nature*, xl., 1, p. 11–12.)

The author has found that a small species of Oligochœta was engaged in destroying several species of cultivated plants. In April, 1888, information was received of "small white worms" doing injury to pot and greenhouse plants. The soil of the pots contained hundreds of Enchytræidæ worms of the genus Enchytraœus, apparently near to *E. Buchholzii*, Vejd.

A sunflower, geranium and tradescantia, were each planted in pots containing carefully sifted earth. When well established, 15 worms were placed in each pot. After two months the sunflower drooped and died, the roots and rootlets being dead, and stem rotting, and within the stem some Enchytræidæ were found alive and active. The other two plants are still living, but the number of worms supplied them was too small. One gardener lost spiræas, vegetable marrows, fuchsias, gloxinias, etc. Many hundred worms were found about the dead roots of each plant, and in both his garden and a neighboring ash-heap were found plenty of the worms.

The writer kept a number of the worms in soil alternately wetted and dried at regular intervals. All the worms lived, but were most active when the soil was wet to complete immersion, and quiescent, apparently dried up, when the soil was dry.

Specimens of the worms were received from Rothamsted, where they had injured clover, at the roots of which they occurred, along with larvæ of Sitones and wire worm. Mr. Willis, superintendent of Rothamsted field experiments, found that, the more decayed the roots, the greater the number of worms; that even healthy plants had a few specimens; that the worms seem sometimes to enwrap the rootlets with their coiled body.

In what manner these worms injure the plant, remains to be observed, probably by sucking the fine root hairs. Under observation the pharynx is rapidly everted and withdrawn in the act of feeding.

## ROOT-TUBERCLES OF LEGUMINOSEÆ.

(By A. PRAZMOWSKI: *Bot. Central-blatt*, xxxvi, pp. 215–9, 248–55, 280–5.)

The various theories with regard to the nature of these structures and of the organisms contained in them, are reviewed, and the results of the author's observations and experiments appended.

To test whether the tubercles are normal or pathological productions, he grew plants of *Pisum sativum* and *Phaseolus vulgaris* in sterilized soil watered with distilled water and protected from all possible access of microbes, side by side with others grown in normal conditions or in sterilized soil and watered with ordinary water in which soil had been soaked. In all of a large number of experiments, abundance of tubercles were found on the root in the latter cases while not a single one could be seen on those from which the possibility of infection had been excluded. Under normal conditions the tubercles appear to be formed about the time of the appearance of the root-hairs.

The filiform bodies found in the tubercles are, according to Prazmowski, true hyphæ-filaments, as Ward has already proved; he does not, however, think with Ward that they enter the root only through the root-hairs, but also through the young epiderm. The tubercles he finds invariably to be formed only where the fungus-hyphæ penetrate the tissue of the root. They branch copiously in the epidermal cells. As soon as the hyphæ reach the lower layers of the bark, the transference of formative materials into them commences. The first substance produced in them is starch; subsequently in the inner part of the tubes is formed the so-called "bacteroid-tissue," in which are found the peculiar bodies regarded by some observers as of the nature of bacteria, or detached portions of the fungus-hyphæ by others as simply unorganized food-materials. The author does not agree altogether with either of these views; he regards them as internal protoplasmic structures found within the fungus-hyphæ before the development of the "bacteroid-tissue." Their form varies in different species; in Phaseolus and Lupinus they maintain during their whole existence the form of bacterium-like rods; in Pisum, Medicago and Vicia they branch; in Trifolium they are usually pear-shaped.

With regard to the nature of the fungus, the author regards it as belonging properly neither to the Hyphomycetes nor to the Myxomycetes, but presenting in some respects the closest analogy to *Plasmodiophora Brassicæ*, differing from this chiefly in having, in an early stage of its existence, a filiform state, and in the peculiar "bacteroids" contained within its hyphæ. It is possible that these, although not true spores, may have a reproductive function, and may possibly, under certain conditions, develop into plasmodes. With respect to the function of these tubercles, the author is disposed on the whole to agree most with Hellriegel, that the connection between the plant and the fungus is a symbiotic one, and that the fungus enables the host in some way to avail itself, in its nutrition, of the free nitrogen of the atmosphere.

The observations were made chiefly on the species above mentioned, but the following agree also in the general facts: *Vicia sativa*, *V. Faba*, *Lupinus angustifolius*, *L. luteus*, *L. perennis*, *Trifolium pratense*, *T. hybridum*, *Medicago sativa* and *M. lupulina*; the phenomena differing only in unimportant points in the different species.

*Ab.: Jour. roy. micr. soc., 1889, pp. 246-7.*

## UPON THE DISENGAGEMENT OF FREE NITROGEN DURING PUTREFACTION.

(By BR. JACKE: *Landwirthsch. Jahr.*, xvi, pp. 917–939.)

Nitrogenous substances are divided into two groups, of which the first includes the albuminoids and analogous bodies; the second oxygen combinations. The substances of the first group are decomposed during putrefaction into bodies of low molecular weight, organic bases, carbonic acid, ammonia and perhaps free nitrogen; the others undergo reductions. We know that free nitrogen may be disengaged in two cases: during the oxidation of ammonia, and during the reduction of nitric acid.

The phenomena of reduction are unquestionably connected with the vital activity of micro-organisms; but it may be that oxidation changes them by slow combustion, directly to ammonia, while the microbes play in this case an important part, as is shown by a long series of experiments. One source of free nitrogen is when nitric acid reacts upon ammonia, the amides or the amide acids.

The author has adopted the following method: He inserts in a balloon having a long neck, a long tube recurved at the top and bottom, which tube bore in addition a lateral opening by which the matter to putrify and the agent of putrefaction can be introduced. Then the opening is brought to the lamp in a way to be easily closed by a blow-pipe.

The long upright tube is plunged vertically into a basin filled with mercury; the union of the lateral tube with an empty chamber follows, by means of a rubber pipe; this tube is emptied during long intervals, or after filling the apparatus each time with a suitable gas, after having removed all the nitrogen gas, and the lateral opening is closed. The gas which escapes from the putrifying matter is collected below in the vertical tube over mercury.

In this manner the flour of meat, trefoil, prairie herbs, beets, flour and various mixtures was putrefied. The putrefaction was assisted by means of small quantities of earth, of mud from ditches or drains and decaying cheese.

When organic nitrogenous substances, deprived of nitrates, are acted upon, no appreciable quantity of free nitrogen is gathered.

The gaseous products of putrefaction are, according to the case, carbonic acid, hydrogen (or sulfate of hydrogen) or marsh gas.

When on the contrary there are nitrates, which operate in the absence of oxygen, there is noted an energetic reduction of these bodies with production of nitrogen and all the lower oxides of nitrogen, in very variable proportions. The presence of oxygen diminishes but does not suppress this phenomenon of reduction, and to a certain extent it increases the oxidation of the decaying mass, while the reduction diminishes in intensity. The author does not believe, as does Dehérain and Maquenne, that the reduction is not able to take place in the absence of oxygen. Ehrenberg has arrived at sensibly the same results, but he has not established the freeing of protoxide and peroxide of nitrogen; on the other hand he has often found marsh gas. Wollny, however, has observed the freeing of protoxide of nitrogen.

The nitrates are reduced directly, probably under the action of developing hydrogen. This explains why, in freeing themselves from the hydrogen, all the nitrates are destroyed. However, the microbes which have been studied by Gayon and Dupetit caused the reduction of nitrates without freeing nitrogen.

*Ab.: Annales agronomiques, xv, pp. 185–187.*

## PLAT EXPERIMENTS IN AGRICULTURAL CHEMISTRY.

(By J. RAULIN: *Annales agronomiques*, xv, pp. 177–81.)

The author refers to the unequal condition surrounding plat experiments, and details the method employed at the Rhone agricultural experiment station, at Pierre-Bénite, near Lyon.

The experimental field, which is rectangular, is divided into rectangular plats, equal and parallel. Each plat is divided into three equal squares, ten meters on a side, A, B, C; the two extreme squares A and C, treated alike, differ from B, which is a check plat.

In general, the natural fertility of the soil varies regularly in A and C, so that the half sum of their crops is equal to that of B, if the three plats receive the same treatment. The relation of the half-sum of the crops of A and C to that of B, thus expresses the influence of the circumstances which is studied, corrected by the differences resulting in the nature of the soil. In other words, if we rate the crops from each B plat 100, and then correct proportionally the half-sums of the corresponding plats A and C, we will have exact tables of the influences of the circumstances studied.

In 1887 and 1888, this method was tested in comparing the influence of different phosphates upon the cultivation of wheat and maize.

In 1887 phosphates were applied at the rate of 50 kilos acid phosphate per hectare. The B plats did not receive any acid phosphate, while A and C did. All the plats received ammonium-sulphate and potassium chloride in suitable proportions : Below are results :

| Plat. | Fertilizer. | Crop. $\frac{A+C}{2}$ Kil. | Crop. B. Kil. | Crop. $\frac{A+C}{2}$ B=100 | Excess of crops $\frac{A+C}{2}$ over B. | Excess of crops $\frac{A+C}{2}$ to hectare over av. crop of B. which equals 6978 kil. |
|---|---|---|---|---|---|---|
| 1 | Superphosphate of lime | 75.0 | 64.7 | 115.9 | +15.9 | +1109.5 |
| 2 | Phosphorites | 79.8 | 76.1 | 104.8 | + 4.8 | + 334.9 |
| 3 | Phorsphorous scoria | 71.1 | 70.8 | 100.5 | + 0.5 | + 34.9 |
| 4 | Coprolites | 71.9 | 75.0 | 95.9 | — 4.1 | — 286.1 |
| 5 | Precipitated phosphate | 76.2 | 62.3 | 122.2 | +22.2 | +1549.1 |

The same experiment was reproduced upon a farm at Perron, in a clayey soil, fairly rich in humus.

The inequalities of soil in these experiments, showed that the crops of plats B had varied at Pierre Bénite from 62.3 to 76.1, or from 100 to 122.1, and at Perron from 68 to 94 or from 100 to 138.2, that is to say the influences of inequalities of natural soil fertility are at least equal to the maximum influence of phosphates.

The results agree as to the influence of the phosphates : at both places, the superphosphates and precipitated phosphates have given some excess in certain crops, comparable among themselves ; the coprolites, scoria and phosphorites have been much more constant in yield.

Another table is given, showing the effects of manures on maize in 1887 and wheat in 1888. In this table, the least variation occurs with the scoria.

## YIELD AT THE BLOCK OF VARIETIES OF BEEF.

(By P. DUTERTRE : *Progrès agricole et viticole*, vi, pp. 364-5.)

The author, who is a graduate of the Grignon agricultural school, and now director of the coöperative shambles of Nimes, France, offers some figures relating to the value of some of the best breeds of French beef cattle. He refers to the Smithfield (England) show records, as secured from animals abnormally fed, while those he presents represent figures more nearly approaching the normal.

From March 19, 1888, to March 8, 1889, they received at the Nimes' shambles 224 beef animals principally belonging to the Ubrac, Salers, Mezenc and grade Garonnais-Carolais breeds.

Nearly all these were purchased by dead weight, were of good quality and fat. Concerning each animal many exact figures were recorded.

Of 224 beeves killed, the following average figures show the net amount of meat for 100 kilograms of weight:

| | |
|---|---|
| 129 Aubrac cattle gave | 53.91 per cent. |
| 31 Salers " " | 56.98 " " |
| 45 Mezenc " " | 54.61 " " |
| 17 Grade Garonnais-Carolais | 54.37 " " |
| 2 Charolais " " | 56.34 " " |

This weight includes the four quarters without head, liver, lungs, heart and spleen.

Salers' beef is usually the choicest leg meat; the legs are long and very strong of bone. The meat is very compact and firm.

The Mezenc breed is especially notable for the development of the rump, and the fine quality of the quarters. The adipose tissue is very white and is disseminated most regularly over the meat. It is a breed appreciated by connoisseurs.

Grade Garonnais-Carolais are large, tough and of very strong bone. The adipose tissue is rather yellow, and the meat is not fine.

The Aubrac breed stands at the head in the market of Nimes Animals of this breed fed on the lowlands do not produce as high a quality of beef as those fed on the mountains.

## MIGRATIONS OF PENTASTOMUM DENTICULATUM IN CATTLE.

(By DR. V. BABES: *Centr. f. Bakteriol. u. Parasit.*, v. (1889) pp. 1-5.)

The author had in the summer of 1888 the opportunity of examining some 35 cattle which had died of epidemic hæmoglobinuria. In all but one instance he was able to verify the existence of the *Pentastomum denticulatum*. He found numerous specimens of the parasite in the mesenteric glands and between the two peritoneal layers of the mesentery; while in the convexity of the intestinal coils he met with roundish nodules about five mm. broad, and often arranged at regular distances. These nodules contained a living pentastomum larva. As the parasite advances in development, so it proceeds towards the lumen of the intestine; the perforation of the mucosa being accompanied by hæmorrhage. In one case hundreds of parasites were found free in the intestinal canal.

It sometimes happened that living examples were not discovered either in the glands or in the intestinal walls, but the glands were found in various stages of degeneration, and scar-like points were seen in the intestinal coats.

The author is of opinion that the migration path of these parasites is outwards, that is, towards the lumen of the gut, but he does not neglect to notice that they may burrow back into the mucosa for a short distance. The connection between this parasite and the hæmoglobinuria, said to be endemic in Roumania, is very interesting.

*Ab.: Jour. roy. micr. soc., 1889, pp. 212–13.*

## EXPERIMENTS ON THE PUTREFACTION AND FORMATION OF BARNYARD MANURE.

(By J. REISET: *Comp. rend.*, cviii, April 8, 1889.)

The author began his researches in 1854, with the preconceived notion that nitrogen was gradually fixed during the slow combustion of organic matter in presence of alkaline carbonates. In 1856, he came to an opposite conclusion, viz., that in all cases when nitrogenous organic matter undergoes putrid decomposition, a part of its nitrogen escapes in the gaseous condition—a conclusion confirmed by the researches of Lawes, Gilbert and Pugh.

The author believes that the discovery of the chemical activity of microbia opens a new phase of this question. He mentions a *Bacillus denitrificans* observed by Gayon and Dupetit, which even decomposes potassium nitrate with an escape of pure nitrogen. He asks if there is not an abundant source of nitrogen during the decomposition of organic matter under water, and quotes an analysis made by Bunsen of the gases obtained from the mud of a pond in the botanical garden of Narburg, which after removal of the carbonic acid, contained 51.5 per cent. free nitrogen.

## MICRO-ORGANISMS OF PNEUMONIA OF LAMBS AND CALVES.

(By E. SEMMER: *Deutsch. Zeit. f. Their. u. Vergleich. Pathol.*, 1888, p.242.)

Several cases of red-grey hepatization of the lung in calves were observed. From the expressed juice were obtained cocci 0.5 μ in diameter, diplococci 1.0 μ long, and bacilli 1.0 μ long and 0.5 μ broad. Injection of these organisms into calves gave a negative result.

In the pneumonia of lambs, the author found six different kinds of microbes. (1) Large cocci and diplococci 0.5 μ in diameter; (2) medium-sized cocci and diplococci 0.2 μ in diameter; (3) small cocci, diplococci and streptococci 0.1 μ in diameter; (4) rodlets 0.5—1.0 μ long and 0.3 μ broad; (5) small baccilli 0.5 μ long and 0.1 μ thick; (6) strepto-bacteria 0.2 μ long 0.1 μ thick.

Grown in bouillon, on gelatin, and on potato, these developed white colonies of single cocci, yellowish-white colonies of short rods, and on potato, brownish-red colonies of large bacilli. Most of these were probably the result of secondary invasion.

*Ab.: Jour. roy. micr. soc., 1889, pp. 270–1.*

# EXPERIMENT STATION ABSTRACTS.

## ANIMAL PHYSIOLOGY.

### ON THE PRODUCTION OF LEAN MEAT IN MATURE ANIMALS.

(*Cornell university agricultural experiment station. Bull. 5, pp. 20.*)

The following experiment was to determine in a measure the effect on lean meat production in lean animals, by feeding highly nitrogenous food.

Two Yorkshire sows were selected, three and four years of age, that were quite thin in flesh. No. one was slaughtered at once, while No. two was fed 143 days, receiving during that time 327¼ lbs. wheat bran, 83 lbs. cotton-seed meal and 247 lbs. corn meal. The following table gives the composition of the ration: The figures are in pounds.

| | Protein. | Fat. | Nitrogen free extract. | Fibre. | Nutritive ratio. |
|---|---|---|---|---|---|
| September and October ration..... | 18.23 | 7.27 | 73.95 | 89 | 1:5.1 |
| February ration......................... | 6.68 | 2.27 | 29.58 | 29 | 1:5.3 |
| Whole period ration.................. | 71.71 | 25.05 | 304.16 | 3.31 | 1:5.2 |

The table below explains the composition of the two hogs:

| | Hog slaughtered before feeding. | Hog slaughtered after feeding. |
|---|---|---|
| Live weight.......................................... | 207. | 296. |
| Dressed weight, including kidneys........ | 131. | 211. |
| Bones, lbs.............................................. | 13. | 16.63 |
| Total protein matter, lbs......................... | 18.10 | 59.09 |
| Total fat, lbs............................................ | 16.70 | 48.29 |
| Per cent. protein in carcass ..................... | 13.82 | 28. |
| Per cent. fat in carcass............................ | 12.75 | 22.89 |
| Per cent. dressed to live weight............ | 63.29 | 71.28 |

It was assumed that at the time of the slaughter of number one, the composition of the animals was practically the same. The following table clearly expresses the effect of the food on hog number two:

| | Assumed composition before feeding on basis of analysis of No. 1. | Composition after feeding as found by analysis. | Gain or loss in lbs. |
|---|---|---|---|
| Live weight..................... | 240. | 2.96 | 56. |
| Dressed weight................ | 151.9 | 211. | 59.1 |
| Bones ................................ | 16.63 | 16.63 | ...... |
| Protein matter.................. | 20.99 | 59.09 | 38.1 |
| Fat...................................... | 19.39 | 48.29 | 28.92 |
| Water and ash (by diff.)..... | 94.91 | 86.99 | 7.92 |

This paper is graphically illustrated.

## DOES HEATING MILK AFFECT THE QUANTITY OR QUALITY OF BUTTER?

(*Cornell university agricultural experiment station. Bull. No. 5, pp. 13-20.*)

Four parcels of mixed grade Jersey milk, of 14 lbs. each, were treated as follows. (1) Set from cow without treatment at 93°. (2) Cooled to 60° with stirring, strained in another can and set. (3) Cooled as No. 2, then warmed to 93 degrees in water bath. and set. (4) Cooled as No. 2, then warmed to 135 degrees in water bath and set. All set in Cooley Creamer with water at 40°, and skimmed after 22 hours. There was no perceptible difference in the amount of cream secured. The butter was washed but not worked or salted. Lot one weighed 1.03125 lbs.; two, 1.1875 lbs.; three, .9375 lbs. and four, .9375 lbs. Practically this same experiment was repeated, with 48 lbs. of milk, with these results:

| | | |
|---|---|---|
| No. 1 | milk of 6 Jersey cows, untreated | 3.1562 lbs. |
| " 2 | " " " warmed to 135° | 3.25 " |
| " 3 | " 5 Holstein cows untreated | 2.0625 " |
| " 4 | " " " warmed to 135° | 2.25 " |

A rather more elaborate experiment was conducted on the same line, and gave practically the same results.

## PLAT EXPERIMENTS.

### HEMP EXPERIMENTS.

(*Kentucky agricultural experiment station. Bull. No. 18, pp. 8.*)

The object of the experiments was to see if hemp could be grown successfully on old ground by means of commercial fertilizers. The soil was formed from the lower silurian limestones. The fertilizer was applied when the plants were six inches high. The following table gives the comparative results of the different fertilizers:

| Plot. | Fertilizer. | Amount fertilizer. | Yield fiber in lbs. | Quality. |
|---|---|---|---|---|
| 1 | None | | 310 | Trashy, rough, short. |
| 2 | Sulfate potash<br>" ammonia<br>Acid phosphate | 5<br>7½<br>15 | 550 | Fair quality. |
| 3 | Sulfate potash<br>Acid phosphate | 7¾<br>15 | 210 | Rough and short. |
| 4 | Sulfate potash<br>" ammonia | 5<br>7½ | 590 | Good—not A 1. |
| 5 | None | | 150 | Trashy. |
| 6 | Sulfate ammonia<br>" potash<br>Acid phosphate<br>Sulfate iron | 3¾<br>2½<br>7½<br>3 | 370 | Little better than trash. |
| 7 | None | | 190 | Trashy. |

### FIELD EXPERIMENTS WITH CORN.

(*Illinois agricultural experiment station. Bull. No. 4, pp., 37–139.*)

This is an interesting and elaborate bulletin detailing numerous experiments with corn. Classification and variety tests occupy much space. The following results are of general interest:

Where one kernel was planted every three inches, for ensilage corn, more fodder was raised than when a less quantity of seed was used.

In planting, the best results were obtained between May 4 and 19th. In relation to quantity of seed per acre, the number of ears harvested varied from 18.932 when thickest planted, to 5.664, one of the thinnest planted plats.

No marked difference in results was secured from comparing planting in hills or drills, neither did fertilizers give results suitable to draw conclusions of value from.

In root pruning experiments, no difference was at anytime observed between pruned and unpruned in regard to size, vigor or stage of maturity, neither did the yield in any case favor the pruned plats.

### FIELD EXPERIMENTS WITH COTTON.

(*Alabama agricultural experiment station. Bull. No. 5, pp. 16.*)

On 11 plats tested with and without different fertilizers, for two years the best yield of lint came from the application of 420 lbs. kainit per acre. In testing the necessary ratio between nitrogen and phosphoric acid, as food for cotton, the smaller quantity of nitrogen applied seemed to answer all needs of the plant. In testing three forms of phosphoric acid as food for cotton, the general effects from "floats" were most satisfactory. In tests to determine if lime mixed with phosphate will increase the efficacy of the latter, the results seem to indicate not.

## FEEDING STUFFS.

### FODDER CORN OR FODDER CANE.

(*Maryland agricultural experiment station. Bull. No. 3, pp. 29–47.*)

Indian corn and sorghum in Maryland will produce the maximum quantity of green forage or dry substance per acre.

To get the best results, corn should be planted far enough apart to permit easy cultivation and give sufficient air and light. For large varieties, grow single stalks six to eight inches apart in rows three to three and one-half feet apart.

The chemical composition of fodder corn grown in different ways is found to be very similar with the nutritive ratio and percentage of dry substance digestible slightly in favor of thick seeding, though the latter appears to cause a decrease in the relative amount of nitrogen in the albuminoid form.

Plants have the greatest food value when they begin drying and the seeds commence to glaze, and as ordinarily grown, an acre of sowed corn has little more than half the value of the same acre in drills, as above advised.

## AGRICULTURAL SCIENCE NEWS.

A new school of practical agriculture has been established in the province of Reggio-Calabria, Italy.

Mr. John B. Smith, late in charge of the department of insects in the national museum at Washington, has been appointed entomologist to the New Jersey station.

The government of Victoria, Australia, has decided to establish several model dairy farms where pupils will receive instruction in practical and scientific dairying.

The main barn of the Missouri agricultural college was recently destroyed by fire, with its contents. Loss in the vicinity of $12,000, with $4,000 insurance. It is thought to be of incendiary origin.

In *Comp. rendus* (cviii, pp. 98–100) M. C. Tauret describes the preparation, composition and chemical and physical properties of ergosterin, a new crystallizable substance obtained from ergot of rye.

The Georgia southern and Florida railroad intend to establish a model farm, to illustrate the advantages of the country through which that road passes. The professor of agriculture of the Miss. ag. mech. college will assume charge of the same.

A dairy school is being established at Petre, in the Vendee district, France. It will consist of 150 acres, 60 cows and will be fitted with a steam dairy. The age of pupils will range between 13 and 19 years. This is the third establishment of the kind in the province of L'Ouest.

The minister of agriculture of France has decreed that agriculture shall be taught in all the centers of primary instruction, in that country. *Progrès agricole et viticole* says this is not the first time such instruction has been attempted, and heretofore without appreciable results.

The *Rural New-Yorker* of May 25, contains a lengthy contribution by D. G. Porter entitled, "What are the agricultural colleges good for?" The writer expresses his opinion in very positive language not very complimentary and concludes by outlining a plan of management, which he says "would be of incalculable benefit both to agriculturists and agriculture."

The May bulletin of the Kew gardens, contains two beautiful plates, and discusses the following subjects: Persian zalil, the flowers of which are used for dyeing silk, illustrated by plate; Tasmanian woods; lily flowers and bulbs used as food; Pu-êrh tea, a variety grown in south-west China; and the short-podded yam bean, illustrated with plate.

According to H. Potonié (*Naturwiss. Wochenschr.*, iii., pp. 19–21) the sclerenchymatous cells which in the cultivated pear are scattered through the flesh, lie, in the wild forms, in a closed very hard zone surrounding the core; and he regards them as the remains of a shell which, in the ancestors of the present species, inclosed the seeds as is now the case with the medlar and many species of Cratægus, The same applies to the quince and to some oleaceæ.

We quote the following through the *North-British agriculturist* (April 24): It is reported from St. Petersburg that the late Prof. Cienkowsky vaccinated between 1885 and 1889, 20,310 sheep against anthrax. The report says that in one flock of 11,000, the mortality, which had ranged from 8.5 to to 10.6 per cent., fell after vaccination to 0.13 per cent. The average loss after vaccination has been 0.87 per cent. Thirteen months after the inoculation, 18 out of 20 sheep proved invulnerable to the malady.

Before the French academy of sciences, on March 25, M. Aimé Girard discussed some researches on the cultivation of the potato. He deals with the progressive development of the plant, and arrives at the general conclusion that the origin of the starch is to be sought in the leaves, where it is probably represented in its initial form by saccharose, or some analogous sugar. By its two-fold decomposition this sugar becomes on the one hand the generator of the cellular tissue, on the other of the starch which is stored up in that tissue.

The report of Dr. H. E. Stockbridge, as chemist to the Hokkaido Cho, Japan, for the year ending March 31, 1888, is of interest. In addition to the general analytical work reported upon, experimental work of importance was carried out with the apple, hop and grape. The varieties of apples were grown to determine the effect of manures on the fruit. The substance of the hop work has already been detailed in the February issue of this journal. With grapes, the effects of fertilizers upon the fruit of a wine grape was attempted. By the use of potassium oxide, the sugar content was materially increased, the ratio of acid to sugar increasing from 1:12.34 to 1:18.70.

M. Berthelot, before the French academy of sciences, on April 8 read a paper upon the fixation of nitrogen by vegetable soil, with or without the aid of leguminous plants. Sixty-four methodic experiments carried out during the year 1888, were discussed. These are fully described in the April number of the *Annales de chimie et de physique*, and from a sequel to the systematic researches begun by Berthelot in 1883. The results tend fully to confirm the views already announced by him on the fixation of free nitrogen in the ground, effected either with or without the coöperation of lucern, vetches and other leguminous plants.

During the past two years the Miss. agricultural and mechanical college has undergone a severe strain in several directions. The state legislature crippled the institution financially, by cutting down its appropriation, and not allowing it sufficient means for efficient management. Following this came the respective resignations of Profs. Gulley and Myers, both of whom had done exceptionally good work. Within the past three months; B. Irby, professor of agriculture, A. B. McKay, professor of horticulture and B. W. Safford, assistant professor of horticulture, have resigned to accept more lucrative positions elsewhere. It is to be deeply regretted that so excellent an institution as the Miss. college, should be subjected to such hindrances to progress.

The United States department of agriculture has issued the first number of a quarterly bulletin, called the *Journal of mycology*, intended to take the place of the journal lately issued by Prof. Kellerman of that name. This issue makes a very good showing in contents and typography. The following are the titles of papers in this number; Peronosporeæ and rainfall, by B. D. Halsted. An interesting uromyces by the same author. New species of Kansas fungi, by Kellerman and Swingle. A study of the abnormal structure induced by *Ustilago zea mays*, by Etta L. Knowles. Synopsis of North American species of Nummularia and Hypoxylon, by Ellis and Everhart. The genus Scleroderma in Saccardos sylloge, by J. B. Ellis.

Some new species of Hymenomycetons fungi, by Ellis and Everhart. *Triblidium rufulum* Sprenzel by J. B. Ellis. Brief notes on a few common fungi of Montana, by W. F. Anderson. Spotting of peaches, by Erwin F. Smith. Experiments in treatment of gooseberry mildew and apple scab, by E. S. Goff. Notes, by B. T. Galloway.

## EXPERIMENT STATION ITEMS.

Bulletin two of the Oregon station gives data regarding the work in hand in the horticultural department, and records a test of varieties of vegetable seeds.

Bulletin No. 5 of the Texas station is a most excellent exposition of the subject of creameries. Excellent plans are given, with very complete specifications for building a dairy.

The annual report of the Louisiana station embraces 21 pages and includes bulletin No. 21, which details fertilizer tests on corn, sugar cane and general tests of forage plants.

Bulletin 22 of the Indiana station, by the chemist, is upon commercial fertilizers, contains many analyses, the fertilizer laws of the state and gives some notes upon potash, phosphoric acid and nitrogen.

Bulletin number one for 1889, from the Tennessee station, is by Dr. W. E. Stone, chemist, and is upon fertilizers and fertilizing materials. Analyses are given of fertilizers, with considerable additional information on the subject in question.

In bulletin 19 of the Wisconsin station are many valuable practical suggestions concerning the making of ensilage. The contents are based upon researches at the station, but are written in such language that any farmer of ordinary learning can understand them.

Bulletin 22 of the Louisiana station is the annual report of the North Louisana station at Calhoun. This station embraces 330 acres. A number of experiments upon corn and cotton, with fertilizers, etc., are given, as well as a test of varieties of corn and forage plants.

Bulletin No. 14 of the Dakota station, relates to the sugar beet. The beets were harvested Oct. 15, and analyzed the next March. According to the report, unfortunately beets in every sample but one were either wilted, flecked with decayed spots, sprouted or damaged by loss of roots.

Bulletin five of the Alabama station relates to experiments on cotton varieties with fertilizers, and on soils; feeding for pork; description of the station barn, dairy and ice house; methods of feeding for butter; analyses of fertilizers, soils and feed stuffs, terminated with a meteorological report.

Bulletin 37 of the agricultural college at Guelph, Ontario, Canada, is upon strawberries, by Prof. Panton. Bulletin 38 by Prof. Shaw, is on the growth of green fodders. Bulletin 39 by Prof. James treats the composition of milk, while bulletin, 40 by Prof: Robertson, gives notes for cheese makers for May.

At the request of the committee on coöperative work in horticulture, appointed by the association of American agricultural colleges and experiment stations at the Knoxville meeting, an edition of forms for reports of horticulturists has been published by the office of experiment stations of the U. S. department of agriculture.

Dr. Halsted in bulletin 52 of the New Jersey station takes up the weed question of that state, gives a scale of points to aid in ranking weeds, and offers questions for answer. Bulletin 53 is on the prices of nitrogen, phosphoric acid and potash, giving schedule of value adopted by experiment stations for 1889, and explaining how these valuations may be put to practical use. Bulletin 54 is on potash as a fertilizer, with conclusions drawn from work at the station, showing this manure to be of special value on corn, sorghum, and sweet potatoes. Bulletin 55 contains entomological suggestions and inquiries.

Bulletin seven of the Colorado station discusses experiments with varieties of potatoes and sugar beets. A very interesting table, which is well arranged, gives the yield in pounds, number of hills, per cent. of starch, condition April 1, and remarks on potato varieties. The varieties are recorded according to starch content, and it is to be noted that the wild potato, *Solanum Jamesii* contained more starch than any named variety. The named varieties averaged 17.17 per cent. starch, and the seedlings 18.85 per cent. The methods of potato analysis are given by the chemist, as well as some beet sugar determinations.

Bulletin seven of the New Hampshire station gives a test of dairy implements conducted under the auspices of the board of agriculture, dairyman's association and experiment station. Five methods were tested for creaming milk: Moseley and Stoddard, Cooley, Johnson top can, shallow six quart pan and De Laval hand separator. The efficiency of the system was graded as follows: De Laval, 91.10; shallow pan, 91.07, M. & S., 82.11 and Cooley, 80.36. The butter was graded as follows:

| | Perfect mark. | M. & S. | Cooley. | Johnson. | Shallow. | De Laval. |
|---|---|---|---|---|---|---|
| Flavor | 50 | 40 | 43 | 50 | 45 | 41 |
| Grain | 25 | 25 | 20 | 18 | 25 | 25 |
| Color | 15 | 14 | 12 | 8 | 15 | 10 |
| Salt | 10 | 10 | 10 | 10 | 10 | 10 |
| Total | 100 | 89 | 85 | 86 | 95 | 86 |

In point of efficiency, from recovered fat in butter, the systems rank as follows: De Laval, shallow, M. & S., and Cooley. In testing the merits of the Davis, Blanchard and Stoddard churns, no practical difference was found in efficiency of work.

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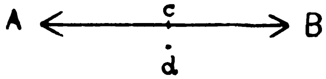
# SOIL MOISTURE: A STUDY.

BY MILTON WHITNEY.

During the course of an investigation, the results of which it is hoped will soon be published, the writer has thought it necessary to familiarize himself with the laws governing capillary movement of moisture in the soil, as well with the physical structure of the soil itself. The following notes on the subject are presented for the benefit of those workers in agriculture who may be interested in this matter. There has been no attempt to cover this subject, for the writer has had neither time nor opportunity to thoroughly look over the work of others. Besides, he found this work though well summarized for example by Johnson and Armsby (Repts. Conn. expt. station, 1887, p. 81–96, with experiments, 1878, p, 83–102 and *Forschungen auf dem Gebiete der Agrikultur Physik*), yet they failed to give exactly the information desired. The writer is glad to acknowledge assistance, rendered in the construction of the mathematical formulae, from Mr. Henry R. Goodnow and to his colleagues Dr. E. W. Davis and Prof. Benjamin Sloan; at the same time he does not wish to shift upon others the responsibility for any misapplication or apparent obscurity of the mathematical expressions which may appear.

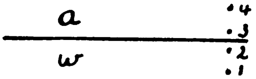
The phenomena of capillary attraction are familiar to all, in the rise of water in very fine tubes, the tendency of oil to spread out on a surface of water, and in general in that surface attraction between three fluids which do not mix or between two fluids and a solid, which manifests itself in a tendency to draw the particles together towards a common center, as with a drop of mercury on glass; or to make them glide over or spread out indefinitely over one another, as with a drop of oil on water. For reasons given above, the phenomena of capillary attraction are considered here only in relation to the rise of water in glass tubes and this only in so far as it may help to explain or give a clear conception of the movement between soil particles.

*Fig 1.*



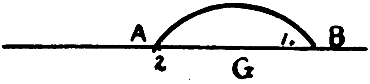
SEC. I. Force may *act* in either direction. Let A and B fig. 1 pull the point c in opposite directions with equal force ; there is no motion but there is a *tension* on the line A B, which will give a resultant motion in either direction if the force is lessened at any point. The point c pulls against A and B with a force equal to their own. Again, if the point c is depressed to d there is a strain along the line A d B tending to restore d to its former position. This is the meaning we shall apply to the term tension ; and when it is spoken of as acting in one way, it is because in the nature of the case, it could not act in the other by reason of other superior forces.

*Fig. 2.*



SEC. II. Consider a plain surface separating the two fluids, air and water. Particles of water at 1 and air at 4, fig. 2 are surrounded and influenced on all sides by particles of a like character, with themselves. On the other hand particles 2 and 3 at the surface of separation, have on one side particles not of the same kind as themselves.

*Fig. 3.*



Again, consider surfaces of water, glass and air, fig. 3. Any particle of the drop of water, at 1 on the extreme surface is attracted by particles of water on one side and of glass on the other, but any surface particle of glass or water near the center of the drop will have particles of unlike character on all sides of half the surface, so there will be tension indeed but no tendency to move. The particles of water at A, however, will be surrounded by particles of water, glass and air, while the particle of glass at 2 just outside the drop is surrounded only by particles of glass and air, but being within the sphere of attraction* of the particles of water at A and having a greater attraction for the water particles than it has for air, and the particles of water having a greater attraction for particles of glass than for particles of water, there is a tendency for the particle of water at A on the extreme surface of the drop, to move out over the glass, and the drop spreads out and wets the glass.

If the surface of the glass is greasy, these surface particles of water have a greater attraction for water particles than for grease so the particles are drawn in and the drop tends to assume a globular shape. The same applies to mercury on glass. In these latter cases it is the air which spreads over the surface of the grease or glass. The force of gravity of course modifies these effects.

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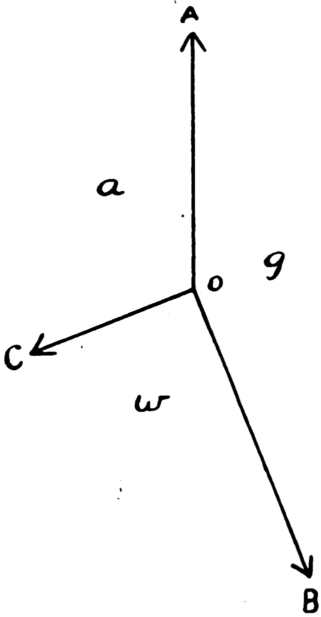
*It is probable that this attraction is sensible only within a distance of a thousandth of a millimeter or so.

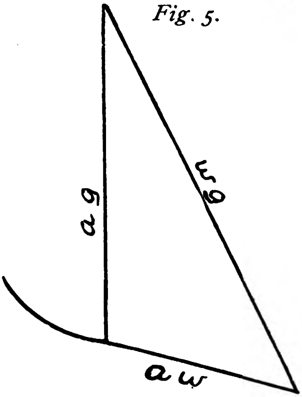
*Fig. 4.*



SEC. III. It can be shown that these forces of attraction between surface particles produce a tension or stretching over the entire surfaces of separation. Further that when three substances come together, it is necessary for equilibrium that the tension should be proportional to the sides of a triangle, said sides to be parallel to the surfaces of separation. For instance, let the lines A O, B O and C O, fig. 4, represent respectively the tension between the surfaces a g, w g and w a, then for all the forces to be in equilibrium, the surfaces will form at the point of intersection the angles as shown at O. These lines can be laid off in a triangle, fig. 5, in which the inner angles are the complement of those at O.

SEC. IV. "But it is not always possible to construct a triangle with three given lines at its sides. If any one of the lines is greater than the sum of the other two, the triangle cannot be formed. For the same reason, if any one of the three superficial tensions is greater than the sum of the other two, the three fluids cannot be in equilibrium in contact.

*Fig. 5.*

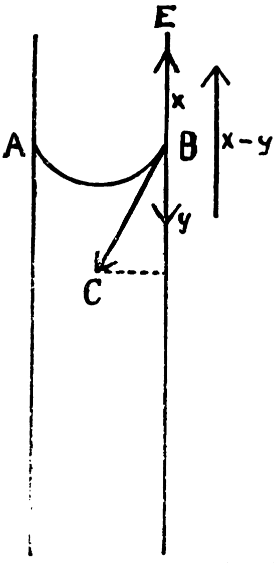


"For instance, if the tension of the surface separating air and water is greater than the sum of the tensions of the surfaces separating air and oil, and oil and water, then a drop of oil cannot be in equilibrium on the surface of water. The edge of the drop where the oil meets the air and the water, becomes thinner and thinner; but even when the angle is reduced to the thinnest edge, the tension of the free surface of the water exceeds the tension of the two surfaces of the oil, so that the oil is drawn out thinner and thinner till it covers a vast expanse of water. In fact, the process may go on till the oil becomes so thin and contains so small a number of molecules in its thickness, that it no longer has the properties of the liquid in mass.

"When a solid body is in contact with two fluids, then if the tension of the surface separating the solid from the first fluid, exceeds the sum of the tensions of the other two surfaces, the first fluid will gather itself up into a drop, and the second will spread over the surface. If one of the fluids is air and the other a liquid then the liquid if it corresponds to the first fluid mentioned above, will stand in drops without wetting the surface ; but if it corresponds to the second, it will spread itself over the whole surface and wet the solid.

"When the tension of the surface separating two fluids is greater than the difference of the tensions of the surfaces separating them from the solid, then the surface of separation of the two fluids will be inclined at a finite angle to the surface of the solid. * * * * This angle is called the angle of capillarity."[1]

*Fig. 6.*



SEC. V. Consider a capillary tube (fig. 6) partly immersed in water. The glass being rigid, the surface of the water in the tube takes the form A B, giving the capillary angle at B, where the surface has the inclination tangent to the tension B C. This angle is determined by lowering the end C, of the line representing the tension of the air-water surface, until its projection on the side of the tube E Y shall be equal to the difference in tension of the glass-air and glass-water tension. There is a further tension along the surface of the water and glass on the line B Y, which we have laid off equal to y, which tends to pull all the particles of water together and to pull the particle B down. There is also a tension greater than this on the air-glass surface E B, which we have represented by the arrow x which tends to pull the particles of air together and to pull the particle B up the tube. The difference between these two, or x—y, is represented by the arrow to one side. This tension of the surface of air stretched out along the glass, tends to pull the particles of air together as a stretched rubber cloth tends to contract. As the particles of water pull down with only a force of y, the water rises in the tube until the weight of water so raised balances the excess of tension (x—y).

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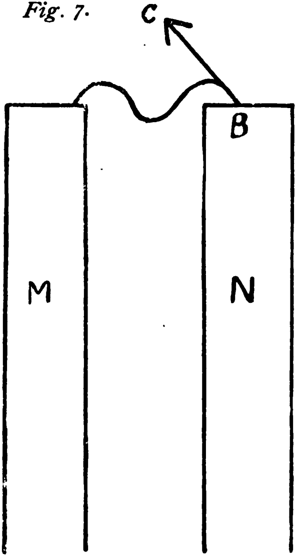
[1] Maxwell. Theory of heat, p. 285.

SEC. VI. The height to which a liquid may rise in a capillary tube, whose surface it wets, is inversely as the diameter of the tube.

SEC. VII. Consider a capillary tube (fig. 6) shorter than the height to which water could be raised in such a tube, with its lower end immersed in water. The liquid will rise in the tube to the top. The force x—y still predominates for the reason that it is greater than the force of gravity acting on the particle B, so that the particle B will crawl on to the horizontal surface of the top of the glass; but as the capillary angle must always remain the same, the point c on the line B C will be thrown outside of the liquid. The surface has a convex form near the sides of the tube, but still has a concave form in the center thus having a double curvature. This is shown in fig. 7, where M and N represent the side of the tube. Water tends to crawl out over N, but the capillary angle remaining constant, the liquid must rise in the convex form shown. In the case of oil, the fluid would continue to crawl and spread out indefinitely over N, as the angle of capillarity is zero. Water on the contrary cannot spread out over N indefinitely, unless water rises out of the tube, for the angle would grow less and less as the water spreads, which is against capillary laws, as stated. But water cannot rise out of the tube, because the tension of the concave part of the surface which is pulling the water up, is exactly equalized by the force of gravity, plus the tension of the convex part of the surface, which acting with gravity, tends to hold the liquid back in the tube. In the case of a number of tubes, with very thin walls coming together it might happen that the convex part of the surfaces would project far enough to meet, and uniting, the tension would be changed and a drop would form which would run down the outside of the tubes. Especially would this be likely to occur if the tubes were inclined at an angle. This can probably be used in explanation of the action of tile drains—a subject which we hope to work up later.

*Fig. 7.*



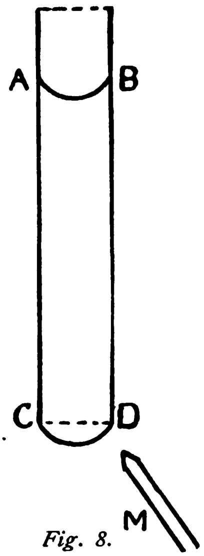


*Fig. 8.*

SEC. VIII. Consider a capillary tube, fig. 8, partly filled with water and suspended in the air. The water will not leave the tube for the reason that the tension on the surface A B, together with the tension on the surface C D, overcome the force of gravity and are sufficient to support the liquid in the tube. Now if the tension at A B be overcome, as for instance by maintaining a constant water supply, then water will leave the lower end of the tube in drops. For this reason, even the finest capillary tubes will act as an ordinary syphon, if allowed to fall over the side of a vessel containing water in which one end dips—the action starting without external aid.

Consider now a piece of glass, M, approaching C D until it touches the surface. The tension will be changed and water may flow out of the capillary tube on to M.

If, as has been said, the tension at A B is relieved by an inexhaustible water supply, for instance, the liquid may drop from C D, from its own weight. This, together, with the substance of Sec. VII, may explain, in part, the work of tile drains in the soil, and in general of water dripping from the roofs of tunnels.

*Fig. 9.*

SEC. IX. Consider any surface particle of water, B. (fig. 9,) under a surface of air. It is vibrating more or less rapidly, according to the temperature. In its gyrations, the particle may fly so far from the surface as to be without the sphere of attraction of other water particles. It thus enters the air as a vapor, and repulses all similar particles so long as the temperature remains constant, and it has free space in the air. This is the *modus operandi* of evaporation.

The particle in its rapid movement in the air, may be thrown again on to the surface of water, so as to come once more within the sphere of attraction of the particles of water, and vibrate as such in a much shorter path than in the air. This on the other hand is the *modus operandi* of condensation, operations which are constantly going on at the same time over every water surface. If one or the other of these actions predominates, we speak of evaporation or condensation as taking place. If the number of particles which leave the water surface, is exactly equal to the number which are thrown against it, as is the case with saturated air, then we say there is neither evaporation nor condensation.

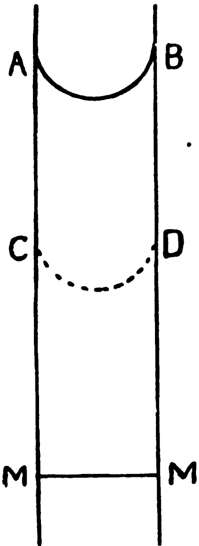


*Fig. 10.*

SEC. X. Consider a capillary tube (fig. 10) surrounded by an atmosphere of water-vapor alone, and sustaining water in a state of equilibrium to a height A B. Now close the tube at MM so that the water cannot pass, and take water out of the tube until the surface falls to CD. Water will rise in the tube by condensation of the water-vapor, by virtue of the curvature of the surface, until the surface is again at AB.* This seems to the writer a matter of much interest in agricultural investigation.

SEC. XI. Liquids will rise between parallel plates to half the height to which they would rise in a tube whose diameter is equal to the distance between the plates, and the pressure on the inner surface of the plates is *less than the atmospheric pressure* by half the weight of the liquid between the plates. The pressure on any particle of water in a capillary tube is less than the atmospheric pressure, by the weight of the column of water between it and the water level outside the tube. An illustration of this is seen in the tendency of plates to go together when held a short distance apart, with the lower edges immersed in water, or of corks and other light bodies floating on water to stick together.

SEC. XII. The volume of flow of liquids through capillary tubes is proportional to the fourth power of the radius. The height to which water is raised in capillary tubes diminishes with an increase of temperature. Water near the boiling point passes 5 times more rapidly through capillary tubes than water near the freezing point.

SEC. XIII. This surface attraction or tension of which we have been speaking acts at small but measurable distances. As stated in a foot note to Sec. 2, it is probably less than a thousandth of a millimeter. That it does so act has been shown in the following way. The tension of the surface separating liquids from air, water, mercury, glass, silver, etc., varies so that the curve of the surface will vary with the nature of the material. Now it has been shown that in a silvered glass tube, the curve of the surface of water is a mean of what it would be in a silver tube and in a glass tube, separately, showing the influence of both the silver and glass, and that the influence of the glass is felt through the silver lining of the tube.

This subject will be continued in a consideration of the probable physical structure of the soil, with an attempt at an application of some of the foregoing principles to the movement of soil moisture.

University of South Carolina and experiment station, Columbia, June, 1889.

(*To be concluded.*)

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*The proof of this as well as some interesting applications are given in Maxwell's Theory of heat, p. 287.

# EDIBLE PLANTS OF THE WORLD.

BY E. LEWIS STURTEVANT.

For many years I have been in the habit of taking notes regarding edible plants, and it seems to me that it is of sufficient interest to tabulate some of the results. I cannot pretend to have exhausted the field, nor in all cases to have found synonyms, but I have done the latter in a sufficient number of cases to largely reduce my apparent list. Among edible plants I have counted all those which either habitually or during famine periods are recorded to have been eaten. Among the cultivated edibles I have counted those species only whose cultivation is stated, and not implied. Had I accepted implied cultivation, or those grown in botanic gardens, my list would have been quite largely extended.

In the Index Generum Phanerogamorum, Bentham and Hooker, published by Durand, the number of species given count up 110,663, but in the case of 63 orders, the number of species is not stated. Our authors recognize 210 natural orders, and 8,349 genera.

After careful collation, I find my notes include among edible plants, 4,233 species, belonging to 1,353 genera and 170 natural orders. Some of the genera however, are classed as subgenera by Bentham and Hooker. We may say that about three and one-half per cent. of known species of plants can be eaten in one way or another.

My notes on cultivated food plants furnish 1,070 species belonging to 401 genera and 92 natural orders. That is, mankind cultivates for food use rather less than one per cent. of the known species of plants, or about one-quarter of the species here recorded as edible.

The following table explains itself:—

| | Order. | No. of known species. | No. of species recorded as edible. | No. of species recorded as cultivated for food use. |
|---|---|---|---|---|
| i. | Ranunculaceae.......... | 680 | 22 | 4 |
| ii. | Delliniaceae.............. | 200 | 8 | 1 |
| iii. | Calycanthaceae......... | 4 | 2 | —— |
| iv. | Magnoliaceae ............ | 85 | 10 | 1 |
| v. | Anonaceae.................. | 450 | 53 | 8 |
| vi. | Menispremaceae........ | 150 | 9 | —— |
| vii. | Berberideae............... | 105 | 32 | 7 |
| viii. | Nymphaeaceæ .......... | 35 | 17 | 2 |
| ix. | Sarraceniaceae........... | 10 | —— | —— |
| x. | Papaveraceae............ | 80 | 8 | 4 |
| xi. | Fumariaceae............... | 130 | 1 | —— |
| xii. | Cruciferae.................. | —— | 105 | 39 |
| xiii. | Capparideae............... | 350 | 33 | 1 |
| xiv. | Resedaceae............... | 45 | 1 | —— |
| xv. | Cistineae................... | 71 | 1 | —— |
| xvi. | Violaceae................... | 270 | 7 | —— |
| xvii. | Canellaceae............... | 5 | 1 | —— |

| | | | | |
|---|---|---|---|---|
| xviii. | Bixaceae | 180 | 13 | 5 |
| xix. | Pittosporeae | 90 | 12 | — |
| xx. | Tremandreae | 27 | — | — |
| xxi. | Polygalaceae | 470 | 1 | — |
| xxii. | Vochysiaceae | 130 | 1 | — |
| xxiii. | Frankeniaceae | — | 1 | — |
| xxiv. | Caryophylleae | 1100 | 11 | — |
| xxv. | Portulacaceae | 145 | 9 | 3 |
| xxvi. | Tamariscineae | 45 | 2 | — |
| xxvii. | Elatineae | — | — | — |
| xxviii. | Hypericineae | 240 | 1 | — |
| xxix. | Guttiferae | 370 | 36 | 4 |
| xxx. | Ternstroemiaceae | 310 | 17 | 6 |
| xxxi. | Dipterocarpeae | 180 | 1 | — |
| xxxii. | Chlaenaceae | 15 | — | — |
| xxxiii. | Malvaceae | 800 | 51 | 12 |
| xxxiv. | Sterculiaceae | 730 | 32 | 7 |
| xxxv. | Tiliacea | 470 | 43 | 4 |
| xxxvi. | Lineae | 235 | 2 | 1 |
| xxxvii. | Humiriaceae | 32 | 2 | — |
| xxxviii. | Malpighiaceae | 600 | 14 | 2 |
| xxxix. | Zygophylleae | 110 | 8 | — |
| xl. | Geraniacea | 985 | 37 | 11 |
| xli. | Rutaceae | 780 | 52 | 28 |
| xlii. | Simarubeae | 110 | 5 | — |
| xliii. | Ochnaceae | 160 | 3 | — |
| xliv. | Burseraceae | 275 | 13 | 3 |
| xlv. | Meliaceae | 550 | 15 | — |
| xlvi. | Dialypetalae | — | — | — |
| xlvii. | Olacineae | 275 | 6 | — |
| xlviii. | Ilicineae | — | 9 | 1 |
| xlix. | Cyrilleae | — | — | — |
| l. | Celastrineae | 300 | 8 | 1 |
| li. | Hippocrateaceae | 155 | 15 | — |
| lii. | Stackhousieae | — | — | — |
| liii. | Rhamneae | 475 | 44 | 4 |
| liv. | Ampelideae | 435 | 53 | 8 |
| lv. | Sapindaceae | 950 | 42 | 6 |
| lvi. | Hippocastanaceae | — | 4 | — |
| lvii. | Aceraceae | — | 7 | 2 |
| lviii. | Melianthaceae | — | 1 | — |
| lix. | Staphyleaceae | — | 2 | — |
| lx. | Sabiaceae | 40 | — | — |
| lxi. | Anacardiaceae | 430 | 63 | 10 |
| lxii. | Coriariae | — | 2 | — |
| lxiii. | Moringeae | — | 2 | 1 |
| lxiv. | Connaraceae | 170 | 3 | — |
| lxv. | Leguminosae | 7000 | 320 | 119 |
| lxvi. | Rosaceae | 2000 | 239 | 78 |
| lxvii. | Saxifragaceae | 650 | 40 | 8 |
| lxviii. | Crassulaceae | 485 | 10 | 3 |
| lxix. | Droseraceae | — | 1 | — |
| lxx. | Hamamelideae | 40 | 2 | — |
| lxxi. | Bruniaceae | 45 | — | — |
| lxxii. | Halorageae | 85 | 1 | — |
| lxxiii. | Rhizophoraceae | 50 | 4 | — |
| lxxiv. | Combretaceae | 280 | 12 | 3 |
| lxxv. | Myrtaceae | 2100 | 162 | 17 |

| | | | | |
|---|---|---|---|---|
| lxxvi. | Melastomaceae | 2500 | 37 | — |
| lxxvii. | Lythrarieae | 365 | 6 | 1 |
| lxxviii. | Onagrariae | 330 | 19 | 5 |
| lxxix. | Samydaceae | 160 | 1 | — |
| lxxx. | Loasaceae | 115 | 1 | — |
| lxxxi. | Turneraceae | 85 | — | — |
| lxxxii. | Passifloraceae | 235 | 36 | 6 |
| lxxxiii. | Cucurbitaceae | 633 | 73 | 42 |
| lxxxiv. | Begoniaceae | — | 11 | — |
| lxxxv. | Datisceae | — | — | — |
| lxxxvi. | Cactaceae | — | 35 | 3 |
| lxxvii. | Ficnideae | — | 20 | 2 |
| lxxxviii. | Umbelliferae | 1400 | 156 | 35 |
| lxxxix. | Araliaceae | 375 | 9 | 3 |
| xc. | Cornaceae | 80 | 20 | 1 |
| xci. | Caprifoliaceae | — | 25 | 2 |
| xcii. | Rubiaceae | 4500 | 62 | 8 |
| xciii. | Valerianaceae | 275 | 15 | 5 |
| xciv. | Dipsacaceae | 150 | — | — |
| xcv. | Calycereae | — | — | — |
| xcvi. | Compositae | 10200 | 157 | 49 |
| xcvii. | Candolleaceae | 105 | — | — |
| xcviii. | Goodeniaceae | 210 | 1 | — |
| xcix. | Lobeliaceae | 540 | 3 | — |
| c. | Campanulaceae | 550 | 18 | 7 |
| ci. | Vacciniaceae | — | 37 | 3 |
| cii. | Ericaceae | 1080 | 20 | 1 |
| ciii. | Monotropeae | — | — | — |
| civ. | Epacrideae | 325 | 5 | — |
| cv. | Diapensiaceae | 8 | — | — |
| cvi. | Lennoaceae | — | — | — |
| cvii. | Plumbagineae | — | 1 | — |
| cviii. | Primulaceae | 315 | 2 | — |
| cix. | Myrsinaceae | 550 | 12 | — |
| cx. | Sapotaceae | 400 | 45 | 10 |
| cxi. | Ebenaceae | 250 | 28 | 7 |
| cxii. | Styraceae | 235 | 4 | — |
| cxiii. | Oleaceae | 300 | 9 | 2 |
| cxiv. | Salvadoraceae | — | 5 | — |
| cxv. | Apocynaceae | 1035 | 25 | — |
| cxvi. | Asclepiadeae | 1700 | 30 | — |
| cxvii. | Loganiaceae | 360 | 7 | — |
| cxvii. | Gentianeae | 575 | 9 | — |
| cxix. | Polemoniaceae | 150 | — | — |
| cxx. | Hydrophyllaceae | 130 | 3 | — |
| cxxi. | Boragineae | 1235 | 21 | 5 |
| cxxii. | Comolonlaceae | 870 | 27 | 10 |
| cxxiii. | Solanaceae | 1500 | 159 | 60 |
| cxxiv. | Scrophularineae | 2000 | 14 | 2 |
| cxxv. | Orobanchaceae | 150 | 2 | — |
| cxxvi. | Lentibulariaceae | — | — | — |
| cxxvii. | Columelliaceae | — | — | — |
| cxxviii. | Gesneraceae | 960 | 3 | — |
| cxxix. | Bignoniaceae | 500 | 12 | — |
| cxxx. | Pedalineae | 46 | 9 | 5 |
| cxxxi. | Acanthaceae | 1500 | 5 | — |
| cxxxii. | Myoporineae | — | — | — |
| cxxxiii. | Selagineae | 140 | — | — |

| | | | | |
|---|---|---|---|---|
| cxxxiv. | Verbenaceae | 740 | 16 | — |
| cxxxv. | Labiatae | 2700 | 76 | 46 |
| cxxxvi. | Plantagineae | — | 4 | 1 |
| cxxxvii. | Nyctagineae | 120 | 9 | 1 |
| cxxxviii. | Illecebraceae | 90 | 1 | — |
| cxxxix. | Amarantaceae | 450 | 32 | 18 |
| cxl. | Chenopodiaceae | 520 | 46 | 27 |
| cxli. | Phytolaccaceae | 55 | 7 | 2 |
| cxlii. | Batideae | — | 1 | — |
| cxliii. | Polygonaceae | 750 | 57 | 24 |
| cxliv. | Podostemoneae | 116 | 2 | — |
| cxlv. | Nepenthaceae | — | 1 | — |
| cxlvi. | Cytinaceae | 27 | 1 | — |
| cxlvii. | Aristolochiaceae | 225 | 2 | — |
| cxlviii. | Piperaceae | 1025 | 18 | 6 |
| cxlix. | Chloranthaceae | — | 1 | — |
| cl. | Myristicaceae | — | 6 | 1 |
| cli. | Monimiaceae | 150 | 8 | — |
| clii. | Laurineae | 900 | 29 | 5 |
| cliii. | Proteaceae | 950 | 13 | — |
| cliv. | Thymelaeaceae | 400 | 1 | — |
| clv. | Penaeaceae | 20 | — | — |
| clvi. | Elaeagnaceae | — | 19 | 5 |
| clvii. | Loranthaceae | 520 | 3 | — |
| clviii. | Santalaceae | 200 | 11 | — |
| clix. | Balanophoreae | 35 | 3 | — |
| clx. | Euphorbiaceae | 3000 | 47 | 11 |
| clxi. | Balanopseae | — | — | — |
| clxii. | Urticaceae | 1560 | 116 | 21 |
| clxiii. | Platanaceae | — | — | — |
| clxiv. | Leitnerieae | — | — | — |
| clxv. | Juglandeae | — | 15 | 6 |
| clxvi. | Myricaceae | — | 9 | 3 |
| clxvii. | Casuarineae | — | — | — |
| clxviii. | Cupuliferae | 420 | 53 | 10 |
| clxix. | Salicineae | — | 5 | — |
| clxx. | Lacistemaceae | — | — | — |
| clxxi. | Empetraceae | — | 2 | — |
| clxxii. | Ceratophylleae | — | — | — |
| clxviii. | Hydrocharideae | 40 | 2 | — |
| clxxiv. | Burmanniaceae | 50 | — | — |
| clxxv. | Orchideae | 5000 | 20 | 3 |
| clxxvi. | Zingiberaceae | 470 | 50 | 21 |
| clxxvii. | Musaceae | — | 22 | 12 |
| clxxviii. | Bromeliaceae | 525 | 6 | 1 |
| clxxix. | Haemodoraceae | 125 | 4 | — |
| clxxx. | Irideae | 770 | 19 | 1 |
| clxxxi. | Amaryllideae | 650 | 23 | 1 |
| clxxxii. | Taccaceae | — | 5 | 1 |
| clxxxiii. | Dioscoreaceae | 170 | 39 | 24 |
| clxxxiv. | Stemonaceae | — | 1 | — |
| clxxxv. | Liliaceae | 2300 | 125 | 26 |
| clxxxvi. | Pontederiaceae | — | 2 | — |
| clxxxvii. | Philydraceae | — | — | — |
| clxxxviii. | Xyrideae | — | — | — |
| clxxxix. | Mayacaceae | — | — | — |
| cxc, | Commelinaceae | 300 | 7 | 2 |
| cxci. | Rapateaceae | — | — | — |

| | | | | |
|---|---|---|---|---|
| cxcii. | Flagellarieae | —— | 1 | —— |
| cxciii. | Juncaceae | —— | 1 | —— |
| cxciv. | Palmae | 1100 | 102 | 12 |
| cxcv. | Pandaneae | —— | 8 | —— |
| cxcvi. | Cyclanthaceae | —— | —— | —— |
| cxcvii. | Typhaceae | —— | 1 | —— |
| cxcviii. | Aroideae | 900 | 39 | 17 |
| cxcix. | Lemnaceae | —— | —— | —— |
| cc. | Triurideae | —— | —— | —— |
| cci. | Alesmaceae | 55 | 3 | 1 |
| ccii. | Naiadaceae | 120 | 6 | —— |
| cciii. | Eriocauleae | —— | —— | —— |
| cciv. | Centrolepidaceae | —— | —— | —— |
| ccv. | Restiaceae | 240 | —— | —— |
| ccvi. | Cyperaceae | 2200 | 11 | 2 |
| ccvii. | Gramineae | 3500 | 114 | 66 |
| ccviii. | Gnetaceae | —— | 4 | —— |
| ccix. | Coniferae | 300 | 46 | 4 |
| ccx. | Cycadaceae | —— | 15 | 1 |
| | Total | | 4233 | 1070 |
| | Dicotyledons | | 3557 | 875 |
| | Monocotyledons | | 611 | 190 |
| | Gymnospermeae | | 65 | 5 |

Of the lower orders of plant, I have found recorded as edible:—

| | Edible. | Cultivated. |
|---|---|---|
| Equisetaceae | 2 | |
| Filices | 26 | 1 ? |
| Marsiliaceae | 1 | |
| Musci | 1 | |
| Lichenes | 19 | |
| Algae | 43 | 2 |
| Fungi | 339 | 3 |

Vilmorin-Andrieux et cie, in Les Plantes Potageres, Paris, 1883, note 211 species, referable to 126 genera and 33 natural orders, and this may be taken as the extreme numbers for European and American kitchen garden use. Somewhat over 1500 varieties are enumerated.

This presentation, involving some considerable labor, may not be without usefulness to agricultural students. In any event, it is calculated to afford a basis for curious statistical deduction.

So. Framingham, Mass., April, 1889.

# RECENT LITERATURE.

SEVENTH ANNUAL REPORT OF THE BOARD OF CONTROL of the New York state agricultural experiment station, Geneva, Ontario Co., for the year 1888, with reports of the director and officers. Albany, 1889, pp. 428.

In his introduction to this report, Director Collier announces an important change of policy in the management of the station. It is that hereafter the ordinary work of the farm is to receive a larger share of attention than has been given it hitherto. There can be no question that true progress in agriculture must begin in the laboratory; but it is alike unquestionable that the work of the laboratory must be tested and confirmed under the conditions which prevail in field and stable, before it can be made of practical benefit to the farmer. But the American farmer of to-day is not prepared to subject the conclusions of the laboratory to this final test. Where he has received any education beyond training in the mere rudiments of knowledge, this education has almost universally been in the direction of "arts and literature," rather than in that of the applications of modern science to agriculture. It is probably easier to-day to find a cast-away Latin dictionary on the farm than a text book of chemistry. But where is the use of discoursing on nitrification, or corn-fertilization, or plant-classification, to the man who has given no thought to the mysteries of growth and reproduction? Let us first arouse him by a demonstration of effects that will appeal directly to the eye; then we may hope to see him begin the study of causes.

So far, therefore, as the policy of this station relates to the study *in the field and stable* of such questions as the conservation of soil-fertility, the improvement in varieties and in methods of culture of agricultural plants, and the better nourishment of the animals of the farm, I believe it is well devised.

A special feature of this new policy, however, contemplates the comparative testing of various breeds of live-stock, with a view to determining their relative merits; the plan proposed being to place a few individuals of each of several breeds on the station farm, and there subject all to the same treatment and care.

The station farm contains only 125 acres, much of which must be devoted to other lines of work, and consequently the number of animals which can be taken from each of six or eight breeds must be very small. These animals, moreover, are to be selected and donated by men or associations that have made a business of the study of the peculiarities of their respective breeds, and therefore it is to be expected that only phenomenal animals will be donated to the station, and not at all such animals as will show the average working capacity of the breed. But the difference in actual value between individuals in each of the breeds is far greater than the difference between the averages of the different breeds. There is no meaner dairy cow on earth than some that can be found enrolled in the Jersey and Holstein herd-books, notwithstanding the unquestioned fact that these same breeds have furnished the most valuable of dairy cows. For these reasons I find it difficult to conceive how any facts, whose value will be at all commensurate with the cost of the work, can be obtained from such a test as that proposed and believe that the stations which are contemplating such tests, would better devote their energies to other lines of work.

The principal features in the report of the first assistant are an experiment with poultry which suggests that there is here a wide field for future work, and an experiment with a large number of varieties of sorghum. It seems unfortunate that in this case the energy and labor required to execute so extensive an experiment could not have been expended under a climate more friendly to sorghum than that of New York.

The reports of the horticulturist and assistant horticulturist give evidence of much well systematized labor, and lead one to hope that this labor may not be expended upon an area so small that its results can never have their full measure of value. To illustrate, it seems from this report that some 225 varieties of apples and 350 of pears, peaches and the smaller tree fruits are under test. But trees, like animals and men, have their idiosyncrasies, and even had they not, differences of soils are such that it would be practically impossible to make a fair comparative test of so many varieties where but one individual of a kind is under test.

A feature of the report of the horticulturist might well, it seems to me, have been extended to the entire report; namely: the index to the reports of the horticulturist and assistant horticulturist for the years 1882–87, inclusive. Such indices to the work of the older stations may be quite serviceable to the stations which have begun operations first under the Hatch act.

The report of the chemist covers a wide field, including studies of the chemical composition of the soil and of vegetation, analyses of fertilizers, and a series of digestion and feeding experiments. A prominent feature of the work has been the study of the effect of fertilizers upon the composition of vegetation, and similar studies of the influence of food upon the chemical composition of flesh and butter. A very useful feature of this report is an exhibit by diagrams of the comparative amounts of fertilizing matter in various grains and feeding stuffs.

Several feeding experiments are reported, in each of which but two animals are employed, except in one case where several sheep were fed in lots of two each. In this case part of the sheep were killed by improper food, but just how many were so killed and just what the food was that caused the mishap are not definitely stated, hence other experimenters inexperienced in the practicabilities of sheep feeding are left in the dark. An indefiniteness in the numbering of the pens leaves the reader in doubt respecting the actual number of sheep under experiment.

The report of the farm superintendent deals with grasses and forage crops, silos and silage, and plat experiments with fertilizers, and also includes a meteorological summary for the year. The fertilizer experiments seem to have been carefully conducted, the crops being oats, grass and corn, and the general results are summed up in the following terse statement:

"Potash gave no positively noticeable effect.

"Phosphoric acid hastened maturity.

"Nitrogen delayed ripening and lengthened the growing season."

The entire report occupies 428 pages. It seems to be well indexed, but many will regret the omission of a table of contents and of a roster of the officers of the station.

These, however, are but secondary matters, as compared with the evidence which abounds throughout the report of conscientious, well directed effort. CHAS. E. THORNE.

STUDIES ON THE CHINCH BUG, 1885–1888. By S. A. Forbes, Ph. D., state entomologist, Champaign, Ill., pp. 57, Springfield, Ill., 1889.

This pamphlet is from the 16th report of the state entomologist of Illinois, and is of very great interest. Prof. Forbes has given much attention to the chinch bug, from an economic standpoint, and has materially added to our useful literature concerning this pest. Considerable attention was given to the relative damage to the different crops it feeds upon in Illinois, and the injury to all crops combined, compared with the average of each, and these are well shown by diagrams. Notwithstanding the generally good proof reading, in his errata, the author fails to correct the error on p. 17, where the number 2,265 is used when it should be 2,986, in fourth line below table v.

Below we quote some of the principal conclusions of the author:

Severe drought in the middle and latter part of the summer may diminish the chinch bug by lessening the food supply for future generations. This occurs in the case of wheat and corn in particular.

Where wheat is abandoned in a district badly infested by chinch bugs, the insect may live and breed very successfully in spring in oats, young timothy, blue grass and corn.

Investigation of the relations of chinch bug injury to the acreage of the principal farm crops of Illinois in 1886 and 1887, shows that, when the outbreak was but just beginning, the wheat area had evidently much to do with the number and rate of increase of insects, the area and number increasing in a fairly constant ratio, other crops remaining much the same or declining. As the severity of the attack increases, the oat area begins to rise with the wheat and may surpass it, with corn and grass finally making a like showing. When the eggs of the winter brood are being freely laid on all the food plants of the species, the wheat area may decline as one passes from districts where destruction is very great to those in which it is complete. Further comparison of the crop areas of 1886 with the injuries of 1887, shows that a very decided diminution of the corn area has had little or no effect to diminish the loss to small grain the following year.

Regarding defenses against the chinch bug, the published opinions of economic entomologists show a general and rather indiscriminate dependence on the abandonment of wheat culture, as the best method. The author secured good results from various experiments looking in this same direction. The worst infested fields of small grain may be sustained under chinch bug attack by heavy fertilization, if the land be originally in good condition; and that in general, the damage done will vary inversely to the fertility of the soil and the support given by fertilizers to the crop attacked. The best fertilizers are first barn-yard manure, and second, phosphates and nitrates combined. Kerosene emulsion has repeatedly proven a valuable agent in the hands of farmers when applied to the field for corn protection. It will, however give the best results, if used in connection with obstructions about the fields, of ditches containing coal-tar with oil or grease, ten parts to one. Tobacco water was less effective than kerosene emulsion. Infusion of lobelia, coal tar-water, turpentine emulsion, lime-water, fresh gaslime, arsenic, London purple, Paris green, Egyptian insecticide, buhach, corrosive sublimate and steam gave inferior results.

Three contagious fungus diseases of the bug are noted, two being caused by thread fungi (Entomophthora and Botrytis), which make a rapid external growth after the death of the insect, covering it with a white mold, while a third is of bacterial origin and is principally located in the cœca of the alimentary canal. The ravages of these parasites are of minor importance at present.

FIRST ANNUAL REPORT OF THE STORRS SCHOOL AGRICULTURAL EXPERIMENT STATION, Storrs, Conn., 1888, Hartford, Conn., 1889, pp. 104.

Perhaps the most interesting and valuable feature of this report, the importance of which cannot be overestimated, if properly done, are the soil tests of fertilizers conducted by farmers in every county of the state. Connecticut is a pioneer in this phase of experimental work, and so far as one can judge from reports, it appears well done.

The experiments for 1888 were divided into three classes, viz.:

(1) for soil tests; (2) for testing the effects of different quantities of the same fertilizers; (3) for studying the effects of different quantities of nitrogen upon the corn crop. Very careful and clearly printed directions are given each farmer doing this work under the station auspices.

In the results secured it is noted that the figures are often uninterpretable, a very common feature of plat tests, but however this is not always so, as some farmers secured positive effects of importance. In these experiments the largest yields as a rule came from complete fertilizers. In many cases, however, one or two ingredients seemed to meet the requirements better. For example, potash in Mr. Dean's case, phosphoric acid and potash in Mr. Bartholomew's and nitrate of soda with Mr. Williams gave the best effects.

The following table, prepared from the results of 80 experiments conducted by Prof. Atwater, is here reproduced as of interest:

| Effects of fertilizing material on corn. | Regulating ingredient. | More or less efficient. | Inefficient. |
|---|---|---|---|
| Superphosphate (Phos. acid)........... | 29 | 34 | 17 |
| Muriate of potash (Potash)............. | 12 | 24 | 44 |
| Nitrate of soda (Nitrogen)............. | 4 | 30 | 46 |

The report further contains matter pertaining to the legislative acts forming the station; "experiments on the effects of tillage on soil moisture," and "roots of plants as manure," both of which subjects have been treated in bulletin form and reviewed in this journal; meteorological observations: grasses and forage plants grown during 1888, and some experimental and other data concerning the cow pea, including a paper on its origin and botanical affinities by Prof. W. H. Brewer of Yale university.

As a first report this is an admirable production, being concise and well arranged. The field covered is not a very broad one, but this is evidence that better work will be done. The typographical features of the report, like other similar Connecticut government publications, are of the highest character.

SECOND ANNUAL REPORT OF THE STATE AGRICULTURAL EXPERIMENT STATION. State of Vermont, 1888, pp. 152, Burlington, 1889.

The second annual report of this station will certainly meet with more approbation from the hands of Vermont farmers, than could have the first, for the reason that a broader field is covered than that of the fertilizer control, or chemical station. Regarding lines of research of the station, the director proposes to make the dairy the most important part of the work, taking up the subject in its broadest sense. Other work will be carried on in the lines of horticulture, entomology and general laboratory work. The latter phase has been a pronounced one of this station in the past, unfortunately necessary through legislative action, but it is a creditable showing of the institution, that it should have practically been the means of improving the character of the fertilizers sold in the state. Since the station became established, there has been a rise in the valuation of fertilizers to the extent of $2.87, and a fall in price of $3.37, a total gain to the farmer of $6.24 per ton. This involved a saving to the farmers of Vermont, during 1888 of $21,000. on account of fertilizers.

Among the items of interest, we note the following: Of 40 farmers who tested alfalfa under the station auspices, no one would recommend it at the end of a year's trial, the climate evidently being too rigorous for it. Prickly comfrey, as a soiling crop was eaten with avidity by cattle. Apple pomace was placed in a silo, well trampled and weighted, where it was perfectly preserved and later fed with success. Field experiments with phosphatic fertilizers were conducted with varying success on potatoes and maize, and the report of the horticulturist is explanatory of future plans, with details of seed germinations and tests of vegetable varieties, grasses and insecticides. The entomologist records a few pages of notes on injurious insects.

Had the several like or similar subjects in this report been arranged together in sequence, and not been so often widely scattered through the pages, the volume would have been materially improved for reference. An excellent table of contents and index is noteworthy. As is the case with too many reports, the tables are frequently arranged so that the headings over the columns of figures cannot be referred to with comfort, usually an unnecessary arrangement. A comparison of the tables on pages 72 and 108 will illustrate the difference. It would be well if station officers should insist on printers setting up such tables for the public ease of use.

## PUBLICATIONS RECEIVED.

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ARKANSAS INDUSTRIAL UNIVERSITY AGRICULTURAL EXPERIMENT STATION, Fayetteville, Ark. Bulletin No. 8, April 19, 1889, pp. 11. Spaying of cattle. Bulletin No. 9, May, 1889, pp. 15. Cotton seed hulls for fattening.

CONNECTICUT AGRICULTURAL EXPERMENT STATION. Bulletin No. 97, April, 1889, pp. 13. Fungus diseases of plants. Fertilizers.

DAKOTA AGRICULTURAL COLLEGE AND EXPERIMENT STATION, Brookings, Dak. Bulletin No. 12, April, 1889, pp. 13. Department of forestry, horticulture and botany. Forestry.

DAKOTA AGRICULTURAL COLLEGE AND EXPERIMENT STATION, Brookings, Dak. Bulletin No, 13, April, 1889, pp. 28, fig. 22. Department of entomology.

DELAWARE COLLEGE AGRICULTURAL EXPERIMENT STATION, Bulletin No. 4, May, 1889, pp. 19, fig. 13, Newark, Del.

FLORIDA, Bulletin No. 5 of the experiment station of. At the state agricultural college, Lake City, Fla. April, 1889, pp. 8.

**GEORGIA**, University of, state college of agriculture and mechanic arts. Georgia agricultural experiment station. Bulletin No. 3, April, 1889, pp. 43–61. Athens, Georgia.

**HILGARD**, E. W., University of California, college of agriculture, Report of the professor in charge to the president, being a part of the report of the regents of the university. 1889; pp. 19.

**ILLINOIS**, University of. Agricultural experiment station. Champaign, May, 1889, Bulletin No. 5, pp. 141–164. Grasses and clovers: Effect of ripeness on yield and composition.

**INDIANA**, Bulletin of the agricultural experiment station of. Purdue university. No. 23. April, 1889, pp. 12. Experiments with corn.

**JAPAN**. Imperial college of agriculture and dendrology, Komaba, Tokyo. Bulletin No. 4, March, 1889, pp. 36. Researches on the composition of several Japanese fertilizers.

**MAINE AGRICULTURAL EXPERIMENT STATION**. Bulletin No. 1, second series, pp. 3. Partial statement of analysis of commercial fertilizers for 1889.

**MICHIGAN**, Agricultural college of. Bulletin No. 45, pp. 7. Department of botany and forestry. Why not plant a grove? Bulletin No. 46 (experiment station), March, 1889, pp. 12. Department of practical agriculture. Potatoes, roots, fertilizers and oats. Bulletin No. 47, April, 1889, pp. 45. Silos and ensilage. Bulletin No. 48, April, 1889, pp. 27, plates 4. Horticultural department.

**MISSOURI AGRICULTURAL COLLEGE EXPERIMENT STATION**, Bulletin No. 6, pp. 10. Experiments on seed germination, pea weavil and apples. Columbia, Missouri.

**NEVADA AGRICULTURAL EXPERIMENT STATION**. Bulletin No. 63, December, 1888, pp. 28. Meteorological report for 1888, by W. McN. Miller. Bulletin No. 4, March, 1889, pp. 10. Meteorological report for January, February and March, 1889.

**NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION**. Bulletin No. 62, Feb. 28, 1889, pp. 85–100, xii. Fertilizer analyses.

**OHIO AGRICULTURAL EXPERIMENT STATION**, Bulletin of the. Columbus. Ohio. Vol. II, No. 1. Second series, No. 8, March, 1889, pp. 19, fig. 29. I. Practical remedies for some Ohio insects. II. Insectcides and their application. III. Methods of collecting, preserving and studying insects.

**PARSONS**, Charles L. A method for the determination of fat in milk, pp. 5. Excerpt, *Jour. of anal. chem.*, III, pt. 2.

**PENNSYLVANIA STATE COLLEGE AGRICULTURAL EXPERIMENT STATION**. Bulletin No. 7, April, 1889, pp. 23. Tests of varieties. Analysis and valuation of fertilizers.

**SOUTH CAROLINA**, University of. Agricultural experiment station at Columbia, S. C. Bulletin No. 5. New series. II. April, 1889, pp. 21. Oats and wheat.

**TENNESSEE**. state agricultural and mechanical college. Bulletin of the agricultural experiment station of the. Vol. II, No. 2, April, 1889, pp. 25–43, fig. 6. Diseases of the Irish potato.

**UNITED STATES DEPARTMENT OF AGRICULTURE**. Botanical division. Bulletin No. 8. A record of some of the work of the division, including extracts from correspondence and other communications. Prepared by Dr. Geo. Vasey and B. T. Galloway. Washington: Government, 1889, pp. 67.

**UNITED STATES DEPARTMENT OF AGRICULTURE**. Office of experiment stations. Circular No. 7. Co-operative field experiments with fertilizers. March, 1889, pp. 39. Circular No. 8. Explanations and directions for soil tests with fertilizers. March, 1889, pp. 11.

**VERMONT STATE AGRICULTURAL EXPERIMENT STATION**. Bulletin No 14, March, 1889, pp. 15. Analysis of fertilizers licensed for sale in the state of Vermont for the year 1889.

# ABSTRACTS.

## UPON THE AMOUNT OF GLUTEN IN WHEAT.

(By GATELLIER and L'HOTE: *Comptes rendus*, cviii, p. 859.)

The authors sought for the influence of the nitrogen upon the wheat, according to its position during growth. White Victoria wheat yielded:

| | Nitrogen. | Gluten. |
|---|---|---|
| After beets in 100 per cent. flour | 1.36 | 9.06 |
| " oats and plowing in lucern | 1.61 | 10.06 |
| " minette and 30,000 kg. manure | 1.68 | 10.50 |

This indicates that the amount of nitrogen in the soil has a marked influence upon the amount of gluten in the wheat.

In another experiment, Victoria wheat was sown after beets, grown on various plats treated with different amounts of ammonium sulfate in connection with superphosphates. The results obtained were as follows :

| Amount manure per hectare. | Rates of nitrogen to phos. acid in the manure. | Nitrogen in 100 parts flour. | Gluten calculated. |
|---|---|---|---|
| 100 kilogr. sulfate ammonia<br>300 " superphosphate | 4:9 | 1.67 | 10.43 |
| 200 " sulfate ammonia<br>300 " superphosphate | 8:9 | 1.82 | 11.37 |
| 300 " sulfate ammonia<br>300 " superphosphate | 12:9 | 2.04 | 12.75 |
| 300 " sulfate ammonia<br>600 " superphosphate | 6:9 | 1.81 | 11.31 |

These results seem to prove that it is possible to increase through culture, the amount of gluten in wheat, and that this depends on the relation of the proportion of nitrogen to phosphoric acid in the manure.

The authors also cite the following. Many species of wheat were cultivated in a very rich soil, at two different places. The figures below indicate the per cent. of gluten in 100 of flour.

| | Roseau. | White Victoria. | Bergues. | Sheriff. |
|---|---|---|---|---|
| Grown at Ferté sous Jouarre......... | 17.31 | 17.68 | 16.18 | 16.12 |
| At Capelle.......................................... | 13.61 | 12.58 | 13.10 | 9.89 |
| Differences | 3.70 | 5.10 | 3.08 | 6.23 |

Here the quantity of gluten is shown to vary greatly with the same variety, favoring the soil richest in nitrogen. Further, three other varieties were grown on two different locations, the soil in one place containing 2.232 parts of nitrogen, and in the other 1.520 part. There was a material difference in gluten per cent. in favor of the wheat grown on the soil containing the most nitrogen.

The above work, however, does not show that richness in soil nitrogen always influences the amount of gluten, as is shown by work at Rothamsted, Eng. From 1845 to 1854 the following average figures were secured on three classes of wheat plats under test.

| | Nitrogen in 200 parts. |
|---|---|
| Without any manure................................................ | 2.13 |
| Ammoniacal salts only............................................. | 2.26 |
| " " and mineral manure.................. | 2.22 |

The results varied much from year to year.

Of the variability in figures, we get good examples from the results at Grignon, France, during studies carried on upon the composition of oat seed during seasons unequally moist, upon plats which had been given different manures :

| Manure | Nitrogenous matter for 100 parts of dried grain. 1876 | 1878 | 1880 |
|---|---|---|---|
| Farm manure | 13.50 | 14.12 | 13.62 |
| Without manure | 12.44 | 6.85 | 14.56 |
| Nitrate of soda | 12.26 | 9.02 | 15.75 |
| Sulfate of ammonia | 13.94 | 11.43 | 14.50 |

The year 1876 was relatively dry, while 1878 was not.

*Ab.: Annales agronomiques, 1889, pp. 228-30.*

## EXPERIMENTS WITH POTATOES.

(By J. J. WILLIS : *Gardener's chronicle*, June 15, 1889.)

This was a test at Putman, Conn., of the effect of dissolved vs. undissolved phosphates on potatoes. The experiments were carried out in the same field. The land on one part had grown a crop of rye in 1887, while the other part was in grass, and had been mown that year.

Over each plat was sowed broadcast four hundred weight per acre of a mixture of sulfates of potash and magnesia, and one and one-half hundred weight per acre of sulfate of ammonia. At the time of planting the potatoes, the land was divided into sections, and various phosphatic manures of equal money value were applied. The following table gives the result :

YIELD OF SALABLE POTATOES PER ACRE, IN 60 LB. BUSHELS.

| | Planted after rye. | Planted after grass. | Average gain by use of phosphate. |
|---|---|---|---|
| Without phosphates | 127 bu. | 139 bu. | ................ |
| Dissolved bone black | 165 " | 177 " | 38 bu. |
| Grand Cayman's phosphate | 164 " | 148 " | 23 " |
| Thomas slag | 156 " | 149 " | 20 " |
| South Carolina rock | 123 " | 152 " | 5 " |
| Bolivia guano | 144 " | 131 " | 5 " |

The results show strikingly in favor of the dissolved phosphate. The basic slag yielded the most small tubers.

## HUMOUS COMPOUNDS IN SOIL.

(By C. G. EGGERTZ : *Bied. Centr.*, 1889, pp. 75-80.)

The author considers that humic and ulmic acids, as generally produced from carbohydrates, are not natural, but laboratory products, while crenic and apocrenic acids are genuine compounds, whose properties are but little known. The real ammonium humates are completely soluble in water, whereas the artificially prepared substances are insoluble after drying. If ammonium humate is heated at 110°, or if dry humic acid is exposed to ammonia, a highly nitrogenous compound is produced, in which the nitrogen is intimately combined with the complex organic molecule. Repeated solution in alkali and precipitation by acid, results in a partial decomposition, but the whole of the nitrogen is not separated. Sulphur and iron, which appear in natural humous compounds, are not present as sulfates or salt of iron, but are to be considered as combined with the organic compounds. Humous soils owe their absorptive capacity for phosphates to the phosphorous which is combined in them, for if this phosphorous is removed by acids, etc., the humous compounds can no longer absorb phosphates. The decomposition which humic acids appear to suffer by repeated solution and precipitation, results in the formation of new compounds which are more soluble in acids than the original substance. Silicic acid appears to be present in peaty soils in the form of ammonium silicate. The amount of matter dissolved out by four per cent. acid from a soil, more than represents the potential plant nutriment, as the natural acid which renders this nutriment soluble is much feebler than the acids usually employed in analysis. Ammonia acts on a soil by decomposing the humous compounds; lime acts beneficially by setting free ammonia, which again reacts on humates.

*Ab.: Jour. chem. soc., 1889. p. 543.*

## CALCIUM IN SOIL.

(By P. de. MONDESIR: *Comp. rend.*, cviii, pp. 185–87.)

Almost all soils, and even those of the most acid character, contain a notable quantity of calcium, which does not exist in the form of calcium carbonate as is usually assumed, but is present in combination with other constituents of the soil. Calcium carbonate, as a matter of fact, is absent from a large number of soils, and the sulfate, phosphate and nitrate are present in very minute quantity, if at all. It follows, therefore, that this compound of calcium with the humoid matter, is the most important form in which calcium is present in soils. The author insists on the importance of carefully distinguishing the different forms in which calcium occurs in any soil.

*Ab.: Jour. chem. soc., 1889, p. 542.*

## DECOMPOSITION OF PROTEIDS IN GREEN PLANTS KEPT IN THE DARK.

(By E. SCHULZE and E. KISSER: *Landw. Versuchs-Stat.*, xxxvi, pp. 1–8.)

The formation of asparagine in green portions of plants kept in the dark was observed by Borodin and confirmed by Müller (*Ibid.*, xxxiii, p. 311), while the simultaneous loss of proteids was proved by experiments made by Schulze and Bosshard (*Ibid.*, p. 117).

The object of the experiments described in the present paper was to determine whether this decomposition of proteids also takes place in growing plants when light is excluded. Oat plants, in pots, were allowed to grow until 45 or 50 c. m. high ; half of the plants were then cut down just above the ground and quickly dried. The remaining plants were kept in a dark room for seven days, and then cut and dried like the others. The plants which had been kept in the dark were partially yellow, but some of the leaves had a fairly bright green color. The following analytical results were obtained with the plants not kept in the dark (a) and with those kept in the dark for seven days (b). The numbers represent the percentages in dry substance :

| | a. | b. |
|---|---|---|
| Total nitrogen | 3.43 | 3.60 |
| Nitrogen as proteids | 2.64 | 1.44 |
| Non-proteid nitrogen | 0.79 | 2.16 |

The decomposition of proteids was, therefore, very considerable. The oat plants which had been kept in the dark were examined for asparagine, which was separated and determined by Sachsse's method. The amount of nitrogen present in asparagine (and glutamine?) was 0.713 per cent., corresponding to 59 per cent. of the nitrogen of the decomposed proteids. Besides asparagine (and glutamine?), compounds of the xanthine and hypoxanthine groups seem to be found. The plants which were not kept in the dark contained only traces of amides.

*Ab.: Jour. Chem. soc., June, 1889, pp. 642–3.*

## RESEARCHES ON THE COMPOSITION OF SEVERAL JAPANESE FERTILIZERS.

(By O. KELLNER : *Bull. 4, Imp. college of agr. and dendr. of Japan*, pp. 36.)

Sixty-three specimens of manures were analyzed, embracing 16 kinds.

Only two kinds of fishes caught around the Japanese islands make up the bulk of fish manure produced, viz. : herrings, *Clupea harengus*, and sardines ; *C. melanosticta*. According to the methods of preparations, fish manure is divided in Japan into *hoshika*, which is simply air dried fish, and *shime kasu*, prepared by boiling, pressing and drying, whereby a part of the fish oil is gained. Ten analyses were made of these two forms of refuse, and an average of the nitrogen, phosphoric acid and oil gives the following results :

| | Shime Kasu. | | Hoshika. | |
|---|---|---|---|---|
| | Sardines. | Herrings | Sardines. | Herrings. |
| Nitrogen | 9.7 | 8.3 | 7.5 | 6.6 |
| Phosphoric acid | 4.0 | 5.6 | 3.7 | 2.3 |
| Oil | 8.3 | 14.4 | 16.3 | 17.7 |

The shime kasu are conseqently preferable from their greater nitrogen content. The hoshika have a drawback in the large quantity of sand which adheres to it.

The shells of sea turtles give an analysis very much resembling the bones of the higher animals, and are richer in nitrogen than the latter, but the composition of their ash is almost identical with bone ash.

The sea cucumber was found to have a considerable nitrogen content, though the proportion of phosphoric acid and potash is slight. Sea cucumbers and star fishes have a large calcium carbonate content—30 to 40 per cent.

Rice bran has a ratio between nitrogen and phosphoric acid, just in harmony with the demands of ordinary cereal and root crops, and undergoes decomposition in the soil with ease.

In the manufacture of vegetable wax from the berries of *Rhus succedanea* and *vernicifera*, two different sorts of oil cakes are obtained. They both are very rich in oil, even after pressure, but are quite nitrogenous and rich in fat.

Saké cakes, made in the manufacture of rice wine, are very rich in nitrogen.

Tofu cakes are prepared from soy beans, which are steeped in water, finely ground in stone mills, and extracted with much water. The tofu is a common human food in Japan, and is rich in protein.

*Astragalus lotoides*, grows spontaneously on paddy lands in many places. Analysis shows it to contain a good supply of nitrogen, and it is strongly recommended as a green manure.

## EXPERIMENT STATION ABSTRACTS.

### PLANT NUTRITION.

### EFFECT OF RIPENESS ON YIELD AND COMPOSITION OF GRASSES AND CLOVERS.

(*Illinois agricultural experiment station.* Bull. No. 5, pp. 141–164.)

Timothy, Kentucky blue, orchard and meadow fescue grasses, and medium red and mammoth red clovers were used in this investigation. The plants were grown on plats of even and full yield, one rod square. The grass or clover was shaken out after cutting, and turned once or twice. If left out over night it was shocked. The following are the most important facts brought out in the investigation concerning each species.

Timothy (*Phleum pratense*.) Cut when in full bloom two days, when it had shed pollen and half its anthers, when the seeds were in the dough, and when the whole or tips of lower leaves were brown. As the grass ripened there generally came a decrease in per cent. of crude ash, fat and protein, and an increase in crude fibre and nitrogen-free extract. In yield, there was an increase of field cured hay during the first two periods between cuttings, and a slight decrease in the third. There was a constant increase of water-free substance from first to last.

Kentucky blue grass (*Poa pratensis.*) Cut when seeds were in milk, and when ripe. Between the two cuttings the percentage of crude fibre and of nitrogen free extract increased slightly, while the crude ash, fat and protein decreased. The word "increased" at the bottom of page 145 of the bulletin, should read "decreased." The first cutting yielded of field cured hay one and two-third ton, and the second cutting two tons, the first 2,508 lbs. water-free substance, and the latter 2,907.

Orchard grass (*Dactylis glomerata.*) Cut when in full bloom, and when seeds were in milk. The average per cent. of crude ash and nitrogen-free extract increased, and crude fat, protein and fibre decreased between the cuttings.

Meadow fescue (*Festuca pratensis.*) The first cutting was made when about one-half the heads had seeds in the milk and the other half were in blossom; second cutting made when seeds ranged from milk to dough stage. Between the cuttings the percentage of crude ash and of nitrogen-free extract increased, while crude protein and fibre decreased. The yield of field cured hay varied from one ton at first cutting to one and one-fifth ton at second, giving respectively 1,424 and 1,954 lbs. water-free substance.

Medium red clover (*Trifolium pratense.*) Cut when in full bloom, and when three-fourths of the heads were dead and a few leaves brown. The per cent. of crude ash, fat and protein decreased, and crude fibre and nitrogen-free extract increased between the two periods. In yield, the total of digestible organic substance was, at full bloom, 1,445 lbs. per acre, for first cutting, and 1,283 lbs. for the second.

Mammoth red clover (*T. medium.*) Cut when first beginning to bloom, when one-half the heads were in bloom and when three-fourths of the head were brown and contained ripe seeds. The per cent. of crude ash, fat and protein decreased; with some irregularity the crude fibre and nitrogen-free extract increased. The nitrogen-free extract decreased from first to second cutting, and the crude fibre from second to the third. The yield per acre of water-free substance for the three cuttings was 3,196, 4,038 and 3,392 lbs. respectively.

## PLANT DISEASES.

### A NEW DISEASE OF THE IRISH POTATO.

(*Tennessee agricultural experiment station. Bull. No. 2, pp. 37-43.*)

Some of the potatoes on the university of Tennessee farm presented a peculiar appearance. They were withered as a rule, and reduced in size, while some were completely dried up and hard. There was little skin discoloration, but over the entire surface, particularly on the sides, there were scattered more or less thickly a great number of little pimples, each surrounded by a little depression. In potatoes but slightly affected, these pimples were scarcely evident, while in other cases they were strongly marked and noticeable. In the advanced stages the pimples with their depressed borders occupied the entire surface of the much shrunked tubers, being separated only by a thin and sharp fold in the now dry skin. In most, if not in all cases, the skin was broken over the points of the pimples, the edges being irregular or ragged as if torn asunder.

The flesh of the strongly diseased tubers was found to be perfectly sound, although slightly wilted. There was no discoloration in the interior, but immediately underneath the pimples to the depth sometimes of a twelfth of an inch, the tissue was brown and apparently dry. Under the microscope, the cell walls of this tissue were found to be somewhat broken, and the starch grains nearly all gone, those remaining being very imperfect. Scattered through the tissue were seen a great number of little worms of various sizes and in all stages of development, which were identified as nematodes. Many were encased in cysts measuring 60x30 mm., while the free nematodes varied in length from 300 to 600 mm. The mouth, at the extreme anterior end, was surrounded by a sucker-like appendage, and the posterior end was rounded and obtuse. The skin covering the body was very finely transversely striate, and in the females, the interior of the body, excepting toward the extremeties, was filled with round granules (eggs) of various sizes.

The author thinks it is by no means certain that the nematode discovered by Dr. Kuhn, as described in *Biedermann's Centralblatt für Ag. Chem.* (1888, p. 842), is the same.

The above described parasite agrees in size and structure with *Tylenchus devastatrix*. The disease was observed upon but one of 16 varieties of potatoes.

## PLAT EXPERIMENTS.

### FIELD EXPERIMENTS WITH CORN.

(*Indiana agricultural experiment station. Bull. No. 23, pp. 1–12.*)

*Early vs. late planting.* Plantings were made May 1, 11 and 21. According to the yields there was a loss from early planting of 5.47 bu. per acre, and a gain from late planting of .31 bu. per acre.

*Deep vs. shallow plowing.* In this the experiments of 1886 and 1888 are compared, with an increase in 1886 of 2.4 bu. in favor of deep plowing, and in 1888 an increase in favor of the same of 0.1 bu.

*Deep vs. shallow culture.* A spring tooth cultivator was used, with results favoring deep culture, of three to four inches, over shallow, from two to three.

*Different rates of planting.* Corn was planted by hand at different distances, and by machine, during the years 1885, 1886 and 1887. In series one of the hand planted, two kernels every 28 inches apart gave the largest average yield for three years, while in series two, three kernels every 36 inches yielded the most. Of the machine planted, with stalks 12 to 14 inches apart the best results were secured. The proportions of stalk and ear did not vary much in the machine planted.

*Effect of previous manuring on yield.* In 1883 gas-lime, superphosphate and horse manure were applied to some very uniform plats, using 200 lbs. each of the lime and superphosphate in 1883, and 300 lbs. in 1884. Of horse manure 48 loads were used in 1883 and 21 loads in 1884. No manure has been used since, though the land has been grown to corn ever since. The immediate effect of the gas lime was injurious. The maximum increase in yield was, in every case, in 1885. Gas lime and superphosphate produced no material effect on the aggregate yield in five years, while horse manure has produced a marked increase.

## TESTS OF VARIETIES OF CORN OR MAIZE.

(*Pennsylvania state college agr. exp. sta. Bull. No. 7, pp. 12.*)

This test was to make observations upon the yield of the corn plant at different stages of its growth, and to test adaptability to the section in which the station is located. Samples for analysis were taken when the plants were in full tassel, when the ear was beginning to fill out, when kernels were in the glaze, and when fully ripe.

Mammoth white surprise, Chester county mammoth and White Giant Normandy failed to fully ripen the grain. Blount's prolific and Breck's Boston market ensilage did not ripen grain, but are specially recommended for ensilage.

The following table is presented as of special interest, as illustrating loss or gain of dry matter in the several varieties:

| Name. | Fully tassel'd | Ears beginning to fill out. | Kernels beginning to glaze. | Mature. | | Gain dry matter bet'wn | | |
|---|---|---|---|---|---|---|---|---|
| | | | | Ears. | Stover. | 1st & 2d stage. | 2d & 3d stage. | 3d&4th stage. |
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Breck's Boston m'rk't ensilage | 1.561 | 1,641 | 4,264 | 2,440 | 3,920 | 80 | 2,623 | 2,146 |
| Blount's prolific | 2,735 | 5.289 | 4.695 | 2,310 | 4,363 | 2,554 | —605 | 2,932 |
| Chester Co. mammoth | 3,392 | 4,337 | 5,690 | 3,073 | 4,308 | 945 | 1,353 | 1,791 |
| Golden beauty | 2,499 | 3,950 | 4.619 | 2,835 | 3,850 | 1,451 | 669 | 2,066 |
| " " | 2,845 | 3,443 | 4.636 | 3.077 | 4,427 | 597 | 1,193 | 2,868 |
| Golden Dent | 2.633 | 3,825 | 5,344 | 2.529 | 4,566 | 1,192 | 1,519 | 1,751 |
| Mam. white surprise | 3,275 | 6,195 | 7,230 | 2,004 | 5,371 | 2,920 | 1,035 | 145 |
| Pride of the North | 1,581 | 2,213 | 3,761 | 2,195 | | 632 | 1,548 | 3,568 |
| Smedley | 1,297 | 2,213 | 3,761 | 2,917 | | 916 | 1,548 | 5,527 |
| White giant Normandy | 2,162 | 2,764 | 4,037 | 2,176 | 4.638 | 602 | 1,273 | 2,777 |
| Flints: | | | | | | | | |
| Self-husking | 408 | 1,212 | 2,048 | | | | | |
| Tuscarora | 1.422 | 2,343 | | | | | | |

## FERTILIZER TESTS WITH OATS.

(*South Carolina agricultural experiment station. Bull. No. 5, pp. 1–16.*)

Fertilizer tests were conducted with nitrogenous and phosphatic manures on two experimental farms of the state. With the nitrogenous manures, the best results ensued from using 163 lbs. nitrate soda, 76 lbs. muriate potash and 120 lbs. acid phosphate per acre. Of the several tests this is the only one that returned a profit on the Darlington farm. On the Spartanburg farm 250 lbs. cottonseed meal, 212 lbs. nitrate of soda, 68 lbs. muriate of potash and 78 lbs. acid phosphate gave the best results. The average results of the two farms gave for the latter application above described, a yield of 32.40 bu. per acre, while the former yielded 24.30 bu.

In using phosphatic manures, Thomas' basic slag and "floats" were compared, and in both cases the increase of yield favored the slag. An application of 300 lbs. per acre was made of each.

## AGRICULTURAL SCIENCE NEWS.

The society for the promotion of agricultural science meets at Toronto, Canada, on August 26, 27.

*Erratum.* Page 24, second table. The headings "fat" and "nitrogen free extract," should be transposed.

Mr. H. D. Richmond describes apparatus for butter analysis in *The analyst* for June. The article is very brief, and illustrated.

The American association for the advancement of science holds its 38th annual meeting, begining Aug., 27, at Toronto, Canada.

The Michigan legislature has appropriated $8,000 with which to erect and equip an agricultural laboratory at the Michigan agricultural college.

Prof. Wortley Axe, of the Royal veterinary college, was recently elected president of the Royal college of veterinary surgeons for the ensuing year.

The Imperial college of agriculture and dendrology, of Tokio, Japan, publishes as bulletin number four, interesting researches upon the composition of several Japanese fertilizers by Dr. O. Kellner.

According to the *North-British agriculturist*, classes for instruction in agricultural science are now very common in the north of Scotland. Last winter there were 39 classes in Aberdeenshire.

A statement made to the British parliament, shows that for the year 1888–89, grants in aid of agricultural and dairy schools were made in 25 cases, ranging from £25, given the horticultural college at Swanley, to £300 to the university of Edinburgh.

Prof. G. E. Morrow of the university of Illinois, is now in Europe, in behalf of the U. S. department of agriculture, to make a report on the live stock exhibited at the Royal agricultural society show at Windsor. He will also visit the continent, and especially France and Germany.

M. Pourquier, director of the vaccinal institute at Montpellier, France, has had good success in inoculating sheep against the scab disease. Attenuated virus is applied at the extremity of the tail. At the national school of agriculture at Montpellier, experiments are now in progress for further testing this method.

Why not plant a grove ? is the title of bulletin 45 of the Michigan agricultural college. As the word experiment station is not printed upon it, we infer that this is issued independent of the station. It is from the department of botany and forestry, and is an imaginary conversation between two persons regarding planting groves of forest trees.

In a previous communication to *Chem. Zeit.* (xii, 1623, 1624) E. Pollak stated that he had detected nitric acid in certain wine musts. He now states, however, that this must have been due to impurities derived from the butts, inasmuch as nitric acid was not detected in the following year in musts of similiar origin or in grape juice.

The report of the professor of agriculture of the university of California, E. W. Hilgard, to the president of the university, covers 19 pages. The report embraces university instruction in agriculture, viticulture, entomology and botany, and experimental work at the Berkeley and sub-cultural station. All through the report there is evidence of a vigorous, healthy growth in the departments.

In experiments to test the reproductive powers of potato tubers, A. Girard in *Comp. rend.* (cviii, pp. 525-27) says that although small tubers may have great reproductive power, the weight of the yield is comparatively small. Medium-sized tubers, however, give practically the same result as the largest, and are therefore the most suitable for seed. He believes it is important to select seed tubers from heavy roots, since large tubers from small roots usually give inferior crops.

Messrs Vasey and Galloway of the botanical division of the U. S. department ment of agriculture, have prepared as bulletin number eight a record of some of the work of the division. Dr. Vasey reports upon grass experiment stations, and describes 14 species of grass worthy of being tested. A few brief notes on grasses, and botanical notes are given as pertaining to the grasses. A monograph of the genus Panicum occupies 19 pages. Mr. Galloway, as chief of the section of vegetable pathology discusses potato scab, gum disease or foot rot of the orange, gives a partial list of the parasitic fungus of Missouri and adds extracts from correspondence as related to parasitic plant disease. The bulletin, which contains much of interest and value, is dedicated to the agricultural colleges of the country.

## EXPERIMENT STATION ITEMS.

Bulletin 62 of the North Carolina station is upon fertilizer analyses.

Bulletin 12 of the Dakota station records the success in tree growing at the station during the years 1887 and 1888.

Mr. A. A. Crozier, botanist at the Iowa station, has resigned his position there, and is located at Ann Arbor, Mich.

Bulletin number one of the second series of the Maine station is a statement of analysis of commercial fertilizers for 1889.

"Analysis of fertilizers licensed for sale in the state of Vermont, for the year 1889," is the subject of bulletin 14 of the Vermont station.

Prof. Wm. Brown, late of the Ontario agricultural college, in Canada, has taken charge of the experiment farm at Dover, Victoria, Australia.

The process of spaying cattle is described in bulletin No. 8 of the Arkansas station. Several animals operated upon passed through the test successfully, and made rapid gain in flesh.

Bulletin 97 of the Connecticut station at New Haven, contains a note calling for information concerning onion smut. The valuation of fertilizers, with some analyses, is also given.

The office of experiment stations of the United States department of agriculture has published excellent explanations and directions for soil tests with fertilizers, as circular No. 8 of that office.

The grass experiment station of the U. S. department of agriculture, at Garden City, Kan., is under the care of J. A. Sewall. It comprises 160 acres and has been rented to the government for five years.

Bulletin five of the Florida station contains several fertilizer analyses, and the Hatch act. This bulletin could have been much better printed, and paging would further improve it. Rev. J. P. De Pass is the director.

Bulletin three of the Nevada station contains a very elaborate meteorological report for 1888. Bulletin five of this station is a similar report for January, February and March, 1889. Bulletins two, three and four are all on the same topic.

At the next meeting of the officers of the experiment stations the North Carolina station will present for endorsement a standard of valuation to be generally used in seed testing at experiment stations and elsewhere. The plan merits cordial support.

Bulletin four of the Delaware station, by Prof. M. H. Beckwith, contains brief illustrated notes of an educational character, concerning injurious insects, their identification and extermination. The insects discussed are the more common ones of the farm.

The department of entomology of the Dakota station has issued a bulletin in which several species of insects are described. Instructions are given for their extermination, and various insecticides and methods and machines for applying them are described and illustrated.

The Alabama canebrake station published in bulletin No. four, experiments with cotton, and meteorological data. The cotton experiments are presented almost entirely in tabular form, and as the writer of the bulletin says, "some of the results are simply inexplicable." It is consequently thought best to draw no conclusions.

Bulletin six of the Missouri station records experiments on seed germination, pea weavil and apples. Seeds were secured from city stores and germinated, to get the per cent. of germination. Prof. Clark, the writer of the bulletin, states that pea and bean weavils may be absolutely killed by soaking the seed in blood warm water from eight to 12 hours before planting. Tests were made of the keeping qualities of apples over winter.

Bulletin 48 of the Michigan station is by Prof. Taft, of the horticultural department, and details experiments with potatoes, kale, squashes and tomatoes. Interesting variety notes are given concerning crosses and seedlings, though the main part of the bulletin is synoptical and tabular matter on the tomato. In experiments in crossing squashes, the evidence went to show that the effect of the cross was shown the first year in the seed only.

Bulletin three of the Georgia station contains reports from the director, chemist and entomologist. The latter gives information concerning *Eudioptis hyalinata*, L., *E. nitidalis*, Cram., and *Strachia histrionica*, Hahn., with suggestions as to means of destroying. Analyses of *Pinus palustris* and *Magnolia grandiflora* are given by the chemist. Dr. Jones discusses the cow pea as a fertilizer, and details some plat experiments with fertilizers on the pea, that give rather enigmatical results. The question of the preservation of the sweet potato is continued from bulletin two.

The March, 1889, bulletin of the Ohio station first discusses practical remedies for some Ohio insects. The injury is very briefly described, and a remedy given for the codling moth, canker worm, apple tree borers, plum curculio, snowy tree cricket, raspberry saw fly, imported currant worm, imported currant borer, striped vine beetle, clover seed midge, clover root borer and Colorado potato beetle. A description of insecticides, with advice as to application follows. Finally, directions are given for collecting, preserving and studying insects. The bulletin is copiously illustrated, and while not detailing original work, is exceedingly serviceable in character.

The Nevada station has issued circular number one, which states that the following investigations will be attempted: (1) The growth of the various farm crops; (2) the growth, treatment and food value of various forage plants and their adaptability to our soil and climate; (3) the best varieties and most satisfactory method of growing garden vegetables; (4) the adaptability and treatment of large and small fruits; (5) the structure, nature and distribution of native and introduced plants; (6) the purity and vitality of seeds; (7) the chemical composition of feeding stuffs, soils, fertilizers and potable waters; (8) the insects of the state and the use of insecticides and insecticide apparatus; (9) the feeding of beef cattle and sheep; (10) forest trees and their care; (11) the diseases of plants and of animals; (12) meteorology and soil temperatures.

The subjects of potatoes, roots, fertilizers and oats are experimentally reported upon in bulletin 46 of the Michigan station. Twenty-eight varieties of potatoes were tested. In testing the amount of potato seed used per acre, it was considered that a medium amount gave better results than whole potatoes or single eyes. In fertilizer tests plaster gave the largest yield, with land not fertilized, next, ashes and potato fertilizers yielding much less than one plat not manured. In the oat tests, the common white oat is considered superior to others in productiveness. Bulletin 47 of the same station covers 45 pages on the subject of silos and ensilage. This bulletin gives (1) seven years' experience with silos and ensilage at the college farm; (2) views of prominent farmers of Michigan on ensilage; (3) experiments with ensilage vs. corn harvested in the ordinary manner; (4) comparative tests of varieties of ensilage corn and (5) tests of forage plants, lucern and orchard grass.

Bulletin 44 of the Michigan station, which gives the data of a three years' experiment on feeding steers of different breeds, is of considerable interest. We gave data concerning this feeding test in vol. two (page 24) of this journal. These steers were all given the same feed. Six of them were exhibited and slaughtered at the Chicago fat stock show in 1888. The carcasses were tested by a committee of three, embracing a feeder, a judge and buyer. From the butcher's and consumer's standpoint, the breeds ranked in the following order: Shorthorn, Hereford, Devon, Galloway. Holstein, Jersey. As to quality and amount of edible meat, they ranked as follows: Hereford, Devon, Galloway, Jersey, Shorthorn, Holstein. The following table concerning these steers gives some of the most important data:

| Breed. | Live wt. at slaughter. lbs. | Weight dressed after 36 h. lbs. | Pounds net to gross wt. | Age in days to Nov. 13. | Weight Nov. 13. | Gain per day from birth. |
|---|---|---|---|---|---|---|
| Devon | 1,240 | 777 | 63 | 965 | 1,270 | 1.31 |
| Hereford | 1,430 | 927 | 65 | 1,112 | 1,445 | 1.30 |
| Jersey | 1,460 | 868 | 59 | 1,173 | 1,475 | 1.26 |
| Galloway | 1,570 | 971 | 62 | 1,000 | 1,600 | 1.60 |
| Shorthorn | 1,810 | 1,210 | 67 | 1,083 | 1,825 | 1.68 |
| Holstein | 1,620 | 1,014 | 63 | 991 | 1,655 | 1.67 |

This bulletin shows six full page illustrations of two cuts from each animal

Circular No. seven of the office of experiment stations of the United States department of agriculture is entitled "Coöperative field experiments with fertilizers." It is a report of a conference of representatives of experiment stations, called by Prof. W. O. Atwater, to discuss the above subject. Sixteen station officials were present at the meeting held early in March at Washington, much interesting matter is published as a result in this report. The following brief facts are of value: Field plats of one-twentieth acre were recommended for general use, the form to be regulated according to local conditions. It was thought best not to recommend any specific time or method for applying fertilizers. The plan of using fertilizers containing nitrogen, phosphoric acid and potash, simply, two by two and all three together was adopted, and the use of uniform kinds and qualities of standard fertilizing materials recommended. The following quantities were recommended for general adoption: For nitrogen, nitrate of soda, 160 lbs. per acre, containing 16 per cent. nitrogen for phosphoric acid, dissolved bone-black, 320 lbs. per acre, containing 16 per cent. soluble phosphoric acid; for potash, muriate of potash, 160 lbs. per acre containing 50 per cent. potash; for sulfate of lime, 160 lbs. high grade gypsum per acre. It was recommended that the outside corners of sections or series of plats be marked with sections of gas pipe, driven to or below the surface, and that at least one such stake be driven along each side of the section. It was thought best to replant missing hills. Great stress was laid upon the duplication of plats. If possible, plats should extend north and south. The words "farm tests" designate work done by farmers under station auspices, while station plat experiments, as referred to this report, are termed "soil tests." A compensation of $10.00 per acre was recommended to be offered farmers engaging in work for stations. This report also contains explanatory matter regarding the conducting of field experiments. It is a very suggestive report.

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(*Concluded from the last number.*)

# SOIL MOISTURE: A STUDY.

BY MILTON WHITNEY.

SEC. XIV. The soil is composed of minute fragments of rocks and minerals differing in size and number in a unit volume of different soils, depending largely upon the nature of the original rocks, on climatic conditions, and upon local surroundings, position, etc. For the same reasons the particles in one and the same soil vary in size ranging generally from 1 and 2 m. m. in diameter down to ultra microscopic dust. In shape the particles on the seashore are approximately spheres, as the angles have been worn away by constant attrition by the moving winds and waters. Inland where this physical action has been only by rains and the natural movements in the soil, the particles are still more or less angular although especially in a well tilled and aerated soil the particles will approach more or less closely a spherical form. In arrangement the particles are piled together in a promiscuous way leaving spaces of different sizes depending upon the size of the particles and whether they fit snugly together or in falling down they become jammed so as to leave relatively larger spaces between the particles. If we should consider the size and shape of each individual particle of soil, and attempt to calculate the actual arrangement, it would be an utter absurdity to expect absolute values for the reason that our knowledge of mathematics is not refined enough for such complicated calculations nor is this refinement necessary. It is proposed then, for the sake of what may be worked out of a theoretical consideration of the subject, to assume that all the particles are spheres, and that they comport themselves in the average as though of a uniform size and symetrically arranged. It will be shown later that the arrangement in the average is really more like spheres than cubes, for with the latter shape it should be possible to puddle a soil so completely and to join the particles so close and compactly together that there would practically be no space for water between the particles. As a matter of fact, however, it would probably be impossible to compact a soil (certainly for a sand or gravel) so far as to have it hold less than 25 per cent. by volume of empty space, which is the amount left in the closest arrangement of spheres (the "cannon ball arrangement.") We shall attempt to show further in another paper, "on the interpretation of the results of mechanical analyses of soils," that from the vast number of particles and the infinite arrangements possible as well as upon other considerations based upon actual analyses which have been examined, that these assumptions can justly be made for the work in hand and the actual size of the particles be taken as that of the average sized particle of soil. These assumptions will be made in these notes without further comment. The spaces between the particles in an arable soil are usually more or less completely filled with water which is probably constantly in motion as a result of the action of gravity and of capillary force. The sides of the particles act as the sides of tubes or of plates, over which the water tends to spread as it does over the surface of glass as has been explained in the first part of this paper. Let us consider now the probable arrangement of particles in different soils.*

SEC. XV. One cubic foot of dry sand weighs about 110 pounds; 1 cu. ft. of heavy clay weighs about 75 pounds[1] or about two-thirds of the former. As the specific gravity of the particles of each are the same (2.65–269)[2] it follows that the unit volume of the clay will contain only $\frac{75}{110}$ or about ⅔ of the mass of matter and of the actual number of particles contained in a like volume of sand, if the particles of each are assumed to be of the same size.

SEC. XVI. The following data from "How crops feed" is accepted and used in the following pages. Coarse quartz sand which is capable of holding 26 per cent. of water by weight, has been found to hold 53.3 per cent. when finely pulverized. "Clay" holds from 40–70 per cent. of water—Brick clay about 66.2 per cent.

WATER HOLDING POWER OF SOILS.

| | |
|---|---|
| Quartz sand | 25 per cent. |
| Clay soil (60 per cent. clay) | 40 " " |
| Loam | 51 " " |
| Ploughed land | 52 " " |
| Heavy clay (80 per cent. clay) | 61 " " |
| Pure gray clay | 70 " " |
| Fine carbonate of lime | 85 " " |
| Garden mould | 89 " " |
| Humus | 181 " " |
| Fine carbonate of magnesia | 256 " " |

SEC. XVII. Assume that sand takes up 25 per cent. of its weight of water, or 44 per cent. by volume. Then the particles will comport themselves as though they were spheres resting one directly over the other, as in fig. 11, which represents a side of one cubic inch containing eight balls each one-half inch in diameter. The volume of solid matter contained in this cu. in. as found by the formula $d^3 \times \frac{1}{6} \pi \times 8$ is 52.36 per cent. of the total volume, leaving 47.64 per cent. of empty space. This is of course independent of the absolute size of the particles, provided they are of uniform size, as the percentage of space would be the same whether a cu. ft. contained one sphere 12 inches in diameter or 1728 spheres one inch in diameter.

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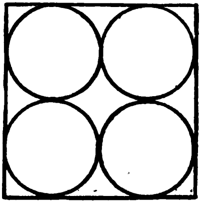
*NOTE. No attempt has been made in the preparation of these notes to verify data used or to obtain results of the most recent experiments on the weight and water holding capacity of different soils, as the substance of the notes is principle rather than fact.

[1] How crops feed, p. 158. [2] *Ibid.*, 159.

*Fig. 11.*



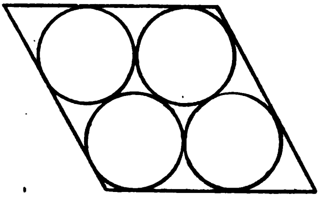
Therefore it may be assumed that in any soil which will hold 25 per cent. of its weight of water, that about one-half of a given volume of the soil is space which contains no solid matter whatever, and that the particles would have the same mean arrangement as spheres of uniform size piled symetrically, as in fig. 11. It is not even necessary to assume the particle spheres, as exactly the same relation between solid matter and empty space would hold if the particles were egg shaped.

SEC. XVIII. From a saturated soil such as is considered in Sec. 17, water can be squeezed by pressure of the hand, i. e., it can be so compacted by pressure and particularly by puddling when an excess of water is present, that it will no longer hold 25 per cent. of its weight of water. The particles can then be conceived to approach the arrangement in fig. 12 which represents one side of a parallelopiped containing eight balls one inch in diameter *. The upper balls have been slipped down so as to rest on three balls and have themselves taken up half of the empty space of the arrangement in fig. 11. This is the arrangement used in piling cannon balls as taking up the least possible amount of room. It can be shown by the formula,

$$\frac{\pi}{3^2\sqrt{2}} \times 8,$$

that 74.05 per cent. of this parallelopiped contains solid matter, and only 25.95 per cent. is space, in which water could be supposed to enter.

*Fig. 12.*



SEC. XIX. Consider the heavy clay of Sec. 16, which weighs 75 lbs. per cu. ft., and which we will *assume* holds 60 per cent. of its weight of water. We have shown the mean arrangement of the particles of sand which weigh 110 pounds in fig. 11.

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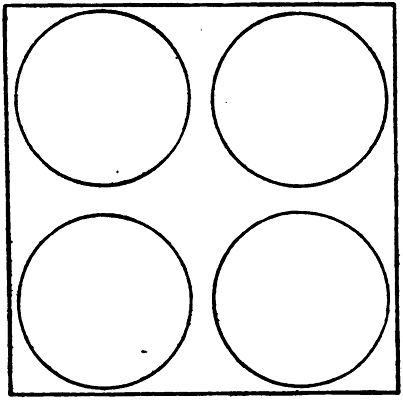
*The upper spheres are really slipped over so as to rest on three spheres, though not so indicated in the cut.

The formula

$$\sqrt[3]{\frac{75}{110}}=0.88015$$

gives the ratio of the sum of the diameters of all the spheres in a unit volume of the clay under consideration to the sum of the diameters of all the spheres in a like volume of sand. Assuming now the actual size of the particles to be the same, and that they are symetrically arranged, we get an arrangement as in fig. 13 which represents a cube of two inches side, containing eight balls. The balls are 0.88015 inches in diameter, but do not touch as there is a space of about 0.12 inch between their surfaces at the nearest point. This proposition is independent of the actual size of the particles. The formula $d^3\times\frac{1}{6}\pi\times 8$ shows that 35.7 per cent. of the cube is filled with solid matter, and 64.3 per cent. is empty space. Let us assume in the absence of experimental data that this particular clay which weighs 75 pounds per cubic foot, is capable of holding 60 per cent. of its weight of water.

*Fig. 13.*



Sixty per cent. of 75 pounds is 45 pounds, which divided by 62.39 (the weight of a cubic foot of water) gives 0.72 cu. ft. of water, which the cubic foot of clay will take up. Seventy-five divided by 2.65 (the sp. gr. of clay) gives 28 pounds as the weight of an equal volume of water, which divided by 62.39 gives 0.45 cu. ft. as the volume actually occupied by the particles of clay and $0.72+0.45=1.17$ cu. ft. as the combined volume of the clay and water. So under the conditions assumed, the clay must swell about 17 per cent. of its superficial volume, in absorbing 60 per cent. of its weight of water, which is probably not an excessive amount, as a matter of fact. We will attempt to explain this swelling of clay, when wet, in sec. 25.

SEC. XX. It will be objected that the soil particles are of an infinite variety of shapes and sizes, but on the other hand it may be claimed that from this very variety, they will approach more nearly some simple arrangement, such as we have suggested, which will give theoretical results agreeing very closely with those found in direct experiments, and this fact would seem to justify the assumption that the soil particles may be considered spheres. This assumption is made in our present method of "mechanical analysis" of soil. In regard to the absolute size of the particles, we have shown that if they are assumed to be of the same size, and symetrically arranged, the proportion between the volume of solid matter to the space in a unit volume, is entirely independent of the absolute size of the particles. Still the actual sizes must be considered in an application of these principles, and we will show in another paper how the actual size and number of particles of each size can be calculated from the mechanical analysis.

SEC. XXI. The arrangement and therefore the absolute volume of solid matter which will go into a unit volume, is largely dependent upon the actual size of the particles. To make the matter clear, we will attempt an explanation of the fact stated in Sec. 16, that quartz sand which will take up 25 per cent. of its weight of water will take up 53.3 per cent. of its weight of water if the sand be finely pulverized.

SEC. XXII. The *volume* of a sphere is found from the formula $\frac{4}{3} \pi r^3$ and the *surface* of the sphere from the formula $4 \pi r^2$. Other things being equal, the weight of a body varies with the volume. Now with spheres of the same material and density, the volume (or weight) decreases proportionately faster than the surface area. For consider a sphere of a radius of one inch. The volume will be $\frac{4}{3} \pi 1^3$ and the surface $4 \pi 1^2$. If now this sphere be reduced in size until the radius is $\frac{1}{100}$ of an inch, the volume will be $\frac{4}{3} \pi \frac{1}{1,000,000}$ and the surface of the sphere will be $4 \pi \frac{1}{10,000}$. If this reduction is carried far enough, as in the case of dust, it may happen that when suspended in the air, the particles can only fall with extreme slowness, as the surface resistance of the air is great, as compared with the weight of the particle, and if the air is in motion particles a thousand times heavier than air may be suspended and blown about for weeks or months.

Sec. XXIII. Consider some smooth, round pebbles (or shot) poured into a bushel measure. The weight of the spheres is so great, as compared with the surface area, that they will jostle each other about to seek the lowest places and take up at once nearly the arrangement of the cannon balls (fig. 12) in which they occupy the least possible space, so that practically they could not be rammed or crowded into any smaller space. There would be not less than 25.9 per cent. of the bushel measure which contains no solid matter whatever. The quartz sand under consideration, if poured into the bushel measure, would not take up this compact arrangement, but the one which we have shown (fig. 11), for the reason that the weight (volume) of the particles has been reduced in greater proportion than the surface area so they will not jostle each other about as much. Such soil as this can be compacted by pounding or puddling, as the particles will assume more nearly the cannon ball arrangement.

SEC. XXIV. Suppose the quartz sand is powdered extremely fine, like road dust, or impalpable carbonate of magnesia, and poured into the bushel measure. Now, the weight of the particles is so extremely small as compared with the extent of surface, that the currents of air formed by the displacement with the powder, which are frequently sufficiently strong to blow many of the particles clear away as dust will act as cushions or springs to prevent the particles settling quickly, and the particles by their own surface interference will form arches and all sorts of groups around relatively large spaces. So the unit volume will be only one-third or less filled with actual solid matter, and the arrangement as a whole will have the mean arrangement of spheres separated from each other as we have shown in the case of clay (fig. 13).

It is needless to say that such a soil can be compacted by pounding or puddling into a much smaller space, when it will of course hold less water.

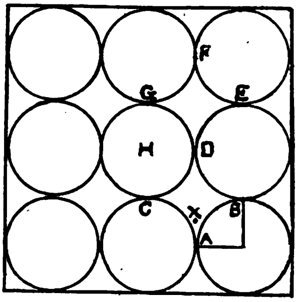
SEC. XXV. It will be interesting in this connection, to attempt an explanation of the swelling of clay and like substances when wet. The weight of the particles is relatively small compared with the surface area. Capillary attraction is a surface phenomenon as has been shown, between surface particles of water, air and a solid (to continue the simple cases we have been considering). The individual spaces between the particles are small, compared with the surface area, and as each particle has a surface attraction for a certain amount of water, it may happen that this amount of water, cannot get to a particle without shoving another particle out of the way, which it can the more readily do as the weight of the particle is extremely small compared with the surface attraction of a particle for water, and also because such small particles can readily be moved as there is so much surface to push against as compared with the weight of the particle to be pushed. Hence the substance swells. This surface attraction between liquids and solids is very great, for think of the practice of splitting rocks by introducing plugs of dry wood into holes in the rock, and afterwards allowing the wood to swell with water. Think also of how oil crawls in between the bearings of huge machinery, supporting in whole or part bearings weighing many tons. Many other illustrations of the force of this surface attraction will present themselves to the reader.

SEC. XXVI. Having resolved the particles of the soil into simple forms and arrangement, let us next consider the relation of the soil to water. It has been shown that at the intersection of surfaces of air, water and glass, the surface of the water takes a certain definite angle in relation to the surface of glass, and it has been shown that the angle varies with the attraction of surface particles of the three substances. With light oil like kerosene, the attraction of the glass or metal for the oil may be so great as compared with other surface attractions of air, oil and solid, and as compared with attractions of oil particles for each other, that the liquid may crawl up the side of a vessel and down the outside. This will happen also from slightly modified causes, with the mixture of alcohol and water in a glass of wine.

We have no data as to the angle of water and soil particles, but it seems probable, reasoning without any direct experimental evidence, that it is greater than in the case of glass. Our reasons for this belief or suggestion are probably almost entirely based on this simple reasoning, that if a smooth, round pebble or polished quartz crystal, be partly immersed in water, the water will rise upon the plain surface to a greater height than it will on glass. This may however be due to inappreciable inequalities in the surface of the rock. Further, air-dry soils contain from less than one per cent. to ten per cent. or over of moisture, the difference being due probably not so much to a greater attraction of the material of one soil over another, as to the greater extent of surface in one soil over another, due to the size of the particles. This moisture, as is well known, is driven off with difficulty even at temperatures considerably over 100° C. Much more difficult than ordinarily in the case of glass, although if the glass were powdered fine, the difference might not after all be so great. This however may pass for what it is worth, as it may be a matter of comparatively little importance.

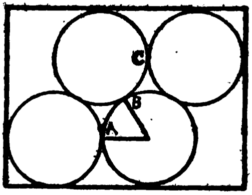
SEC. XXVII. Consider a quartz sand which will hold about 25 per cent. of its weight of water. The particles will have the arrangement of fig. 14, which represents a section at right angles to the surface of such a soil. Now a condition of moisture short of saturation will find the angles at A, B, C, and D filled with water, so far from the point A, B, etc., as the distances between the sides of the particles shall have a certain relation to the diameter of a tube, or to the distance between converging plates which would hold water just that high. One must not think of the space A, B, C, D, as the capillary space, or as representing a capillary tube, for this space is not filled short of saturation, a condition seldom found in arable soil, but which must be assumed in the case of the movement of water in a capillary tube.

*Fig. 14.*



It is the angle A or B or C where the capillary effects have most value, and these may be likened to converging plates. In such an arrangment as this water must crawl up 90 degrees of the circumference of the sphere, to get from A to B. In the arrange-

*Fig. 15.*



ment in fig. 15, it will only have to crawl up 60 degrees of the circumference. Now suppose water is added to a previously dry soil as in fig. 14 so that water shall rise in the angle A. It will not rise to a straight line through B, C in any condition short of saturation but it may rise to a point X (fig. 14). Now if the actual size of the particles is not large, the curvature of the surface may throw water into the angles B and C. The operation will here be repeated and so the angles D, E, F, G are filled, but obviously they cannot be so full as A, for the greater the height above the water supply, the less of the angle will be filled.

It would be more correct to say that the water crawls up over the 60 or 90 degrees of the surface of the spheres and that by reason of the curvature of the surface which has been explained, the horizontal surface will only be drawn up to a point x, and as there will be more surface tension or pull downwards if the water is spread over the surface D E (for we have shown that the tension on any water surface tends to pull the water together into a drop or sphere) there will be less water in the point E than in B, provided the source of water supply is below or that all forces are in equilibrium.

These considerations make the subject all the harder to deal with, but it is important that they be borne in mind. The main thickness of the layer of water on the surface A B, will be greater than on the surface D E, and still greater than on the surface E F.

SEC. XXVIII. If the absolute size of the particles is large, as in coarse sea-sand, it is impossible to raise water very high, as the distance A B, or rather X B, is too great to throw water over, or for water to crawl up. This is seen in the attempt to use such material for sand culture, for where only eight or ten per cent. of water is added to the sand, it nearly all settles to the bottom, giving a saturated soil there with a layer above too dry for plant growth; with a soil of fine particles such an amount of moisture would be nearly evenly distributed throughout a short height of soil.

SEC. XXIX. The limits of this article are too short to allow of the elaboration or consideration of all the points which present themselves, nor is it the intention that these notes shall cover the subject. We expect to work up and publish certain parts of the subject, as time and opportunity will permit. It will not therefore seem out of place to give mere passing mention of matters which the writer is aware will take much time and work to prove or disprove. It follows from Sec. XI that on that part of the surface of the particle of soil, between which and another particle water is held, that the pressure on the surface will be less than the atmospheric pressure, by an amount depending upon the amount of moisture in the soil, from which it would seem to follow that the forces within the soil are in a state of unequal equilibrium, and that each change in the atmospheric pressure or of the amount of moisture in the soil, through evaporation, transpiration or underdrainage, will cause an actual physical movement between the soil particles due to the atmospheric pressure. This will probably account for the compacting effect of rain rather than the actual force of the rain fall, for this compacting effect can be obtained by the introduction of water from below as well as from above a loose, dry soil, and the actual movements can be watched by letting a drop of water fall into dry sand. We have collected some very interesting data pointing to this fact, which we hope at least to elaborate into a theory, and call attention to a number of very interesting and important applications.

SEC. XXX. Consider an arrangement as in fig. 14. The effect of cultivation by stirring the surface soil is to lift the particles up and let them fall gently back, but as was shown in the case of the fine particles of dust, the tendency would be for the particles to become jammed so as to take up more room and leave spaces unoccupied, as though the particle H were removed from fig. 14. Now water will have to be lifted over twice the plain surface, or the entire distance from B to E without the angle D to assist. Of course the obsolute size of the particles will determine the height to which water will be raised in this case, and obviously the angle D E F although remaining the same, will not hold so much water as before the surface attraction of H was removed.

SEC. XXXI. It must be remembered that while we have referred here to conditions of equilibrium or to upward movements of the moisture, that the forces we have been considering act with equal intensity in *all directions* the effect or resultant motion being modified by the force of gravity, or weight of the liquid itself. In the case of rain, after cultivation the soil will evidently hold more water as the particle H (fig. 14) has been removed. The actual size of the particles will determine in large part how much of this water will be held up by the surface, and how much will be drawn down below. The cultivated soil will receive and hold more water from rain and thus reduce surface drainage, but on the other hand it has not as great power to retain the water, as a compact soil as it has not so many particles in the unit volume to attract the water. For the same reason the loose soil cannot raise it to the same height, nor lift it as readily from the subsoil, so that evaporation is hindered.

SEC. XXXII. Consider a soil like fig. 14, after cultivation when the particle H has been removed and which quickly dries. Water entering such a soil will wet the particle G, and will be held between the lower surface of this and other particles, which will lessen the tension on the under side of the particle, and the atmospheric pressure will force G down to the position occupied in this figure by H, and will thus compact the soil again.

It was intended to add to these notes some theoretical calculations on the movement of water in different soils based upon the foregoing principles and the mechanical analysis of the soil, but the matter is reserved until the completion of some experimental work, which is needed to properly formulate our theory, and will be presented in other papers.

University of South Carolina and experiment station,
Columbia, July, 1889.

## RECENT LITERATURE.

REPORT OF THE DEPARTMENT OF AGRICULTURE and of the agricultural experiment station of the university of Minnesota, pp. 417. Supplement I to the fifth biennial report of the board of regents. St. Paul: 1889.

The progress made by the agricultural department of this institution between the years 1881 and'88 was very great. To be sure a very considerable money expenditure was made, but the improvement made was none the less creditable. The farm embraces 248 acres, 200 of which are first-class, is thoroughly equipped with the most modern buildings, stock, implements and machinery, worth at a conservative estimate $400,000. We doubt if there is another college farm proper, excluding other buildings, etc., in America, that has so valuable an equipment.

Quite interesting experimental work is recorded, but only within the past two years has much been done, owing to the lack of workers. The principal work has been in testing vegetables, wheat, potatoes and Russian fruits, silos and ensilage, experiments in stock feeding, the application of commercial fertilizers, the growth of roots, notes on the Rocky mountain locust, fungi which kill insects, etc. The general appearance of the report as regards contents and typography, tends to make a favorable impression.

On page 197, under the illustration, the letter S in S. C. should be N.

The cattle feeding experiment on page 133. though given in detail, we believe gives no facts of consequence. What conclusions can one draw, when of two lots of animals of two each, one of one lot loses 22 and the other gains 35 lbs., while one of the other lot gains 65 and the other loses 15 lbs. in weight between April 13 and May 27 ? If all the experimental work done were published, it would require considerable sifting to separate the useful from the useless, and it is a waste of space to publish results that are absolutely indifferent. The writer, at the present time, has a mass of figures on hand, involving four months of careful feeding and work, that give such indifferent returns he does not feel justified in publishing them. Further, we believe most experimenters will agree with us that, feeding experiments relating to the laying on of flesh, especially, should be long rather than short. A month's test is too unsatisfactory.

On page 230 is given an interesting table of different methods of cutting potatoes, but as it is all embodied in a one-page table, the results are not made so effective as they would have been had the main points been brought out in the text.

An analysis of Rocky mountain locusts, in the interesting report of the entomologist, shows them to contain 10.71 per cent. nitrogen, thus forming a valuable manure.

Several of the bulletins of this station, that we have reviewed in the past are incorporated in this report. The book is illustrated with numerous rather inferior illustrations from photographs, but the pictures give one a conception of the elegant buildings on the grounds. As a whole this report makes a creditable showing.

NINTH ANNUAL REPORT OF THE NEW JERSEY state agricultural experiment station and the first annual report of the New Jersey agricultural college experiment station, for the year 1888. Trenton, N. J.: 1889, pp. 255.

In the second annual report of this station, for the year 1881, is recorded the beginning of a line of investigation with sorghum, in New Jersey, that has gradually grown up to the present time, and yielded results of importance alike to the state and country. In the report before us, this station takes up a field of inquiry new to agricultural investigation, viz.: oyster culture. For 40 pages the biologist gives his attention to the subject in a preliminary report, in which he discusses some points of practical importance in the natural history of the oyster; the extent, product and condition of the natural beds; the clamming grounds; extent and condition of the oyster-planting industry, and the means for improving the oyster-cultural industry. Much statistical data is given, and the entire report is interesting from an agricultural standpoint.

The report upon sorghum is practically the same as issued in bulletin 51 of the station, which we have previously reviewed.

The subject of fertilizers meets considerable attention, and aside from analytical work, the field tests are of special interest, notably those of Mr. Arnold, which began in 1882, (1) to determine the effect of barn-yard manure upon a rotation of crops, compared with the effects of the leading elements of plant food used separately and in combination, and (2) to note the financial results which follow the use of commercial fertilizers. The crops rotated were corn, sweet potatoes, clover and millet. Whenever potash was used with the sweet potato, the improvement in the crop value, varied from eight to 107 per cent. In all cases where potash was excluded, the decrease in the value of the second potato crop was serious, ranging from 36 to 63 per cent. The value of barnyard manure in improving the crop-producing power of the land was estimated at $2.74 per ton. Very generally the use of fine barnyard manure gave the best results, though the quantity used made it less profitable than some others.

The effect of fertilizers on peach trees showed that superphosphate, plaster and barnyard manure could be used profitably.

Considerable data is furnished on fodders and feeds, valuable tables of analyses, of feeding standards, and maximum, minimum and average compositon of fodders. An interesting and brief report on alfalfa is also given.

In view of the high character of the balance of the volume, comparatively speaking, the reports of the entomologist and chemical geologist are rather mediocre, as embracing almost no original work, being mainly compilation. We trust that another year will find these two departments engaged in work equally progressive with the other departments.

THE ENGLISH SPARROW (*Passer domesticus*) in North America, especially in its relations to agriculture. U. S. department of agriculture, division of economic ornithology and mammalogy. Bulletin one, pp. 405, figs. 7, map I. Prepared under the direction of Dr. C. Hart Merriam, ornithologist, by Walter B. Barrows, assistant ornithologist. Washington: Government, 1889.

This report of Mr. Barrows has involved a vast deal of labor, and is no doubt the most elaborate document yet published regarding the relations of any one bird to man, and certainly reflects great credit upon the industrious writer.

The following are the principal topics discussed: Introduction of the sparrow to America; summaries of evidence by many parties concerning the various good and bad traits of this bird; methods of destroying and catching; recommendations for legislations; legislation affecting the sparrows. Dr. C. V. Riley reports upon the insectivorous habits of the bird. Dr. A. K. Fisher gives some experiments upon their destruction by poisons; the trapping of sparrows is described by W. T. Hill, and Otto Widmann gives the history of the house sparrow and European tree sparrow (*Passer montanus*) at St. Louis, Mo.

The following items are of special interest. The first English sparrows were brought to America in the fall of 1850 by Hon. Nicholas Pike and other directors of the Brooklyn institute, who imported eight pairs into Brooklyn. Since then it has rapidly spread over America, approximately spreading, from 1880 to 1885, 500,760 sq. miles, and during 1886, 516,500 sq. miles. A single pair, it is estimated, in ten years will increase to 10,604,499,373 in progeny.

The relation of the sparrow to buds, blossoms and foliage is testified to by 584 observers, of whom 265 allege positive damage to them, 12 are indeterminate, and 307 report no damage. Concerning injury to fruits, garden seeds and vegetables, evidence was received from 788 persons, of whom 472 testified against the sparrow, 279 testified more or less favorably, and 37 for and against.

The relation of this bird to our native birds is of importance, and of 1048 reports bearing on the question, 168 gave no injurious results, while 837 were unfavorable to the sparrow as driving away the native birds from their accustomed haunts.

The English sparrow was originally brought to America to destroy noxious insects, yet the testimony shows that the bird is not strictly insectivorous, or in fact to a slight extent. Of 102 stomachs examined by Dr. Riley, 17.6 per cent. contained insect remains, but, "as a general rule the amount of animal food was but small compared with the vegetable food and gravel." Hymenoptera and Coleoptera mostly prevailed. Of 522 stomachs examined by the agricultural department, 22 contained wheat, 327 oats, 71 maize, 57 fruit seed (mainly mulberries), 102 grass seed, 85 weed seed, 219 undetermined vegetable matter, 19 rice, bread, etc., 47 noxious insects, 50 beneficial insects, 31 insects of no economic importance.

FIRST ANNUAL REPORT OF THE KANSAS EXPERIMENT STATION, state agricultural college. For the year 1888, pp. 357, plates vi, figs. several. Topeka: 1889.

Kansas is strictly an agricultural state, and a large part of the population are farmers. To reach these people, and teach them that which will materially aid and advance them in their labor is the work of the experiment station. Neither the people nor the station officials need feel ashamed of this report, for it shows that a class of work is being done, and answers sought to questions, that directly affect farming interests. We feel no desire to compare this report with those of other stations, but to say that, as a whole, it contains much more grain than chaff.

The reports of the farm, chemical, horticultural and botanical departments follow each other. Prof. Shelton reports on waste of manure in summering manures in the yard; experiments in the corn field; experiments with wheat; tests of forage crops; how milk and butter are influenced by feeding; the pressure of ensilage on silo walls; and the relation of rainfall to the corn crop.

Prof. Failyer has tested the shrinkage of hay in the mow; compared sorghum varieties and tested keeping qualities of sorghum, as well as examined the individual stalk with a view to improving the plant, and also tested with fertilizers. He gives a new method of milk analysis.

Prof. Popenoe besides reporting upon spraying orchards, and giving observations on injurious insects, reports upon trials of varieties of potatoes, peas and tomatoes.

Dr. Kellermann discusses investigations upon sorghum blight and hackberry knot, cross fertilizing varieties of corn, germination of weed seeds, and the fungus parasites of weeds.

Most of the illustrations are generally good. The tabular matter is frequently unpleasant to refer to, on account of the headings so often reading at right angles to the rest of the page-matter, an unnecessary evil. We shall have occasion to make a few abstracts from this volume in future.

## PUBLICATIONS RECEIVED.

ARKANSAS INDUSTRIAL UNIVERSITY AGRICULTURAL EXPERIMENT STATION, Fayetteville, Ark. Bulletin No. 9, May, 1889, pp. 15. Cotton seed hulls for fattening.

CALIFORNIA, University of. Agricultural experiment station, Berkeley, Cal. Bulletin No. 82, pp. 4. The lakes of the San Joaquin valley.

COLORADO, The state agricultural college of. The agricultural experiment station. Bulletin No. 8, July, 1889, pp. 24. Alfalfa: Its growth, composition, digestibility, etc.

CORNELL UNIVERSITY COLLEGE OF AGRICULTURE. Bulletin of the agricultural experiment station. VI. June, 1889, pp. 21–28. I. On the determination of hygroscopic water in air-dried fodders. II. The determination of nitrogen by the azotometric treatment of the solution resulting from the Kjeldahl digestion. III. Fodders and feeding stuffs.

EMERY, Frank E. Report of the farm superintendent to the New York agricultural experiment station, Geneva, N. Y. Extracted from the 7th ann. rep't N. Y. agr. exp. sta. for 1888, pp. 316–403. From the author.

GEORGIA, University of. State agricultural and mechanical college. Georgia agricultural experiment station. Bulletin No. 4, July, 1889, pp. 64–71. Analyses of cattle foods.

GOFF, Emmett S. Report of the horticulturist to the New York agricultural experiment station, Geneva, N. Y. Extracted from the 7th ann. rep't N. Y. agr. exp. sta. for 1888, pp. 86–225.

INDIANA, Bulletin No. 24 of the agricultural experiment station of. Purdue university, May, 1889, pp. 16, illustrated. Experiments on milk production by C. H. Wulff, June, 1889, No. 24, pp. 18. Entomological experiments

IOWA AGRICULTURAL EXPERIMENT STATION. Bulletin No. 5, May, 1889, pp. 141–196. I. Sorghum. II. Important injurious insects.

KANSAS STATE AGRICULTURAL COLLEGE. Experiment station. Manhattan, Kan. Bulletin No. 6, June, 1889, pp. 16. Silos and silage.

KANSAS STATE AGRICULTURAL COLLEGE. Experiment station. Extracted from annual report, 1888. Farm department, pp. 108. Report of botanical department, pp. 281–351. From the authors.

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# ABSTRACTS.

## THE SALTS OF MILK AND THEIR RELATION TO THE BEHAVIOR OF CASEIN.

(By F. SÖLDNER: *Landw. Versuchs-Stat.*, xxxv, pp. 351–436.)

Two series of determinations of the ash constituents of milk gave the following results in grams per litre of milk:

| | Cl. | $P_2O_5$. | $K_2O$. | $Na_2O$. | Ca O. | Mg O. |
|---|---|---|---|---|---|---|
| I | 0.820 | 2.437 | 1.885 | 0.465 | 1.720 | 0.205 |
| II | 0.980 | 2.400 | 1.720 | 0.510 | 1.980 | 0 200 |

The sulfuric acid was not determined, as it does not preëxist in the milk, but is produced from the sulfur of the albuminoids; the small amount of iron was also neglected. In grouping the ash constituents as salts, account has to be taken of the fact that a portion of the phosphoric acid found in the ash is derived from the phosphorus of the casein. The amount of phosphoric acid to be deducted is 0.581 gram per litre of milk, assuming the latter to contain three per cent. of casein.

Hammarsten showed that casein has acid properties, yielding salts with bases, and obtained a calcium-derivative which contained 0.8 to 1.2 per cent. of lime. The author finds that there are two distinct compounds with calcium; the one containing 2.39 per cent. of lime, shows an alkaline reaction with litmus, but not with phenolphthalein; while the other compound does not react either with litmus or with phenolphthalein; and contains only 1.55 per cent. of lime. The basicity of casein was also determined by titration with soda, using phenolphthalein as indicator. Neutral or slightly alkaline solutions of calcium casein, prepared by rubbing together the corresponding amounts of casein and calcium carbonate, become turbid only when kept for some time; but when an alkaline calcium-casein solution is neutralized or acidified it at once becomes turbid. Alkaline, neutral, or just perceptibly acid solutions of calcium-casein do not curdle when boiled; the addition of more acid causes the solutions to curdle, the temperature required becoming lower as the amount of acid present increases. The calcium-derivative which reacts alkaline with litmus is not curdled by rennet. Hence it is probable that casein is present in milk as neutral calcium salt (with 1.55 per cent. of lime). Assuming this to be the case, and making the correction for phosphoric acid already given, a litre of milk will contain in grams:

| | Na Cl. | KCL. | $K_3PO_4$ | $K_2O$ | $Ca_3P_2O_8$ | $Mg_3P_2O_8$ | Ca O (in casein). |
|---|---|---|---|---|---|---|---|
| I | 0.877 | 0.603 | 1.653 | 0.405 | 2.315 | 0.447 | 0.465 |
| II | 0.962 | 0.830 | 0.903 | 0.595 | 2.793 | 0.436 | 0.465 |

The excess of base is probably present in the milk as organic salts, Henkel having shown that citric acid is a contant constituent of milk to the extent of at least one gram per litre.

Analyses of milk serum, prepared by Zahns' method, by filtering milk through porous battery cells, showed that the whole of the potash, most if not all, of the soda, and the greater part of the magnesia present in milk are in the form of soluble salts, so that the casein salt can only be a calcium-derivative. The acidity of milk to phenolphthalein is probably due to the presence of acid phosphates, and to the power of casein of uniting with a further amount of base without becoming alkaline towards phenolphthalein. Calculated from the result of series II, the salts present in milk may be grouped as follows (in grams per litre):

| | | | |
|---|---|---|---|
| Sodium chloride | 0.962 | Magnesium citrate | 0.367 |
| Potassium " | 0.830 | Dicalcium phosphate | 0.671 |
| Monopotassium phosphate | 1.156 | Tricalcium " | 0.806 |
| Dipotassium " | 0.853 | Calcium citrate | 2.133 |
| Potassium citrate | 0.495 | Lime (in casein) | 0.465 |
| Dimagnesium phosphate | 0.336 | | |

Hammarsten (*Jahr. f. Tierchem.*, 1874, p. 135) considers that casein acts as a solvent for calcium phosphate, while Eugling believes that the casein enters into combination with tricalcium phosphate, a view which is also held by Schaffer (*Landw. Jahr. d. Schweiz*, 1887). Eugling's theory is rejected as being based on erroneous suppositions.

Determinations of lime and phosphoric acid were made in milk, in the serum of milk filtered through porous cells, and in the insoluble portion of milk. Thirty-six to 56 per cent. of the phosphoric acid and 53 to 72 per cent. of the lime are undissolved, being probably in suspension. The undissolved lime, not in casein, is in combination with phosphoric acid as a mixture of di and tricalcic phosphates. It was found, that of the undissolved phosphoric acid and lime, 44 to 72 per cent. and 26 to 67 per cent. respectively, could be dissolved in carbonic or acetic acids.

Eugling states that the calcium salts in milk are not precipitated by ammonium oxalate. The author finds that 85 per cent. of the calcium is precipitated; at the same time there is a change in the appearance of the milk which indicates that the reactions which take place extend to the casein, probably with formation of an ammonium salt. Serum obtained by sodium chloride, and that obtained by alcohol, are both precipitated by ammonium oxalate, just like the serum produced by rennet. Eugling's negative result with alcohol serum was, no doubt, due to the presence of alcohol, which is shown to prevent the formation of calcium oxalate.

With regard to the decrease in the acidity in milk, observed by Schaffer to be produced by the action of rennet, it is found that if the casein is made to separate in a finely divided state, so that the whole of it may come into contact with the alkali, and if, at the same time, unnecessary dilution of the curdled milk is avoided, the acidity of the milk remains constant. Boiling has no effect on the acidity of milk.

The belief that casein in milk is in combination with calcium phosphate, originated in Hammarsten's observation that the curdling of milk by rennet is connected with the presence of calcium salts. Hammarsten showed that other alkaline earths may be substituted for lime, and that they may be present as sulfates and carbonates, and still have the same action. It is shown that calcium phosphate suspended in a casein solution does not help the curdling by rennet, but that the presence of a soluble calcium salt is necessary; it is immaterial whether the salt is phosphate or chloride, etc.

According to Mayer (*Milch Zeitung*, x, p. 36) when milk is heated at 75° it undergoes a change, and at still higher temperature, but still much below 100°, it loses its power of being curdled. Experiments made by the author show that milk does not necessarily quite lose the power of being curdled by being heated at 100°, although the time required to curdle milk so treated is much lengthened, especially with milk of less than the usual acidity. The reason that boiled milk will either not curdle at all, or requires a longer time to curdle than fresh milk, is that a part of the dissolved calcium salt is precipitated as tricalcic phosphate. For the same reason curdling of milk by rennet is also prevented, or retarded, by adding more or less alkali. In either case, the property of being curdled by rennet may be restored to the milk by adding acid, passing carbonic anhydride through it, or by the addition of a soluble calcium salt. The author confirms Schaffer's statement that boiled milk treated with carbonic anhydride curdles more quickly than fresh milk.

*Ab.: Jour. chem. soc., June, 1889, pp. 53–64.*

## SOURCES OF THE NITROGEN OF THE GRAMINEÆ AND LEGUMINOSEÆ.

(By H. HELLRIEGEL AND H. WILFARTH: *Beilage. Zeit. Rubenzucker-Ind.*, Nov., 1888.)

The cultures made in 1883–1887 include barley, oats, peas, buckwheat, lupines and sanfoin. The pots employed were of glass, with holes at the bottom, and the soil consisted of quartz sand, used for glass making, from 4 to 8 kilos. being in each pot, and each kilo. containing 0.0027 to 0.0054 gram of nitrogen. The nutrient solution contained definite quantities of potassium phosphate, potassium chloride, magnesium sulfate and calcium nitrate, containing nitrogen in quantities of 0.000, 0.007, 0.028, 0.056, 0.112, 0.168, 0.224 and 0.336 gram. From 0.1 to one per cent. of calcium carbonate was added to the sand, and the plants were watered with distilled water free from ammonia in regulated quantities, so as to keep the percentage of moisture in the soil always within certain limits favorable to growth.

The seeds were selected with great care as to uniformity, and were first allowed to germinate, then sown in the pots, and after the seedlings appeared, half were removed from each pot, leaving only those absolutely uniform in size, hight, etc.

Oats and barley behave alike; without nitrate, there is no development beyond the reserve in the seed, and with varying quantities of nitrate the harvest of dry matter obtained is directly proportional to the nitrate added, and, moreover, the same quantity of nitrate gives always the same weight of dry matter, even in different years. For every milligram of added nitrogen, increases of 93 and 96 milligrams of dry matter are obtained with barley and oats respectively. The harvest always contains less nitrogen than the soil, seed and manure, taken together, and when the added nitrate is diminished, the nitrogen in the harvest is diminished, in the same proportion.

When nitrogen is withheld, or is insufficient, the plants do not die, but there is no production of new matter, the new organs, even to the empty grain spikes, being produced solely at the expense of the older leaves, which are successively exhausted and withered.

Sterilization of the soil and the pots on the one hand, and the addition of the microbes contained in the washings of cultivated soil on the other hand, cause no variation in the above result.

Peas behave quite differently. Some plants languish in a soil deprived of nitrogen, and never develop beyond the reserve material of the seed; but others suddenly acquire new life, develop rapidly, and yield a crop equal in weight to that obtained with a good supply of nitrate, the amount of nitrogen in the crop compared with that contained in the soil, seed and nitrate (if any), varying from a slight loss to a very large gain (over one gram in many instances). This gain occurs also when the pots are placed in a glass cage (as in Boussingaults' experiments) the air of which is carefully deprived of all traces of combined nitrogen; it must, therefore, be due to the free nitrogen of the air. When the soil is sterilized by heat, and the pots and seeds by washing with very dilute mercuric chloride, peas behave like oats and barley; there is no gain of nitrogen from the air, but good crops result proportionally to the quantity of nitrate, and no tubercles are formed on the roots. In all cases where there is a gain of nitrogen, tubercles are formed on the roots. Their formation can be rendered certain by adding to the sterilized soil (with or without nitrate) the washings of a small quantity of arable soil, but the kind of soil, or the crop that has been grown in it, greatly affects the result. When these washings are boiled or even heated to 70°, before being added to the sterilized sand, they are inactive. Thus, the authors infer, the assimilation of free nitrogen from the air by peas, lupines, etc., is not a function of the plant as such, nor can it take place when the growth is in a sterilized medium, but it is connected with the presence of microbes, and with the development of tubercles on the roots.

*Ab.: Jour. chem. soc., June, 1889, pp. 640--1.*

## CHERMES AND PHYLLOXERA.

(By L. DREYFUS: *Zoöl. Anzeig.*, xii, 1889, pp. 65-73, 91-99.)

The author confirms Blochmann's recent account of the bisexual generation of *Chermes abietis*, but the general results of his observations do not agree with those of that author, for he finds that the course of development is much more complicated than has been supposed; indeed it is probable that the cycle is not completed in a single year. He thinks it probable that *C. abietis*, *C. laricis* and *C. obtectus* are all forms in the developmental cycle of one species. The course of development seems to be as follows: in the first year *C. abietis*, having survived the winter, lays eggs; in the gall on the pine a generation is developed which has wings, and this flies out; some members of this generation migrate to the larch, where they lay eggs as *C. laricis;* the third generation passes the winter on the larch as *C. laricis*. At the end of April of the second year there is a fourth generation which escapes at the end of May as *C. laricis;* the greater number of these return to the pine, where they lay eggs as *C. obtectus;* and the fifth generation developed therefrom is bi-sexual. From the fertilized egg the animal which is to live over the winter is slowly developed, and it gives rise to the first generation of the cycle.

The developmental history of phylloxera is also incompletely known and is more complicated than is generally supposed. In many points there is a resemblance to what obtains in chermes, and it is probable that forms which are generally regarded as specifically distinct belong to different periods in one developmental cycle. There are, also, reasons for supposing that external conditions may affect the rotation in which the various stages follow one another. In *P. coccinea* there are two and not only one winged sexupura during the year, for there is one at the end of June, and another at the end of August. In addition to the wingless sexupura of September, described by Balbiani, there are others in July which produce a number of males or females. The author has brought together numerous facts relating to the life-history of these insects, and concludes that, in the natural development of *Phylloxera vastatrix*, the gall-generation never follows directly on the parthenogenetic root generation. The first young form (stem-mother) which arises from the fertilized winter egg and its direct descendants, sometimes for several generations, begins the cycle with the formation of galls.

*Ab.: Jour. roy. micr. soc., 1889, pp. 379-81.*

## NATURAL MODE OF INFECTION OF VIBRIO METSCHNIKOVI.

(*Ann. Instit. Pasteur*, 1888, p. 552. From *Jour. roy. mic. soc.*, 1889, p. 430.)

The disease of fowls, gastroenteritis cholerica, discovered by M. N. Gamaleïa to be caused by *Vibrio Metschnikovi*, agrees in many chemical and pathological aspects with the cholera of man—

temperature, diarrhœa, cramp, acute inflammation of the intestine with copious shedding of epithelium, small spleen, etc. Hence the mode of infection by *V. Metschnikovi* becomes interesting, as throwing light on the infection of cholera asiatica. With regard to the latter, one of the chief objections to the cholera-vibrio of Koch is that gastric juice soon and completely destroys it. Hence the ætiology of Asiatic cholera is far from being explained by the discovery of the common bacillus.

With regard to this new cholera of fowls, it is found that it is not contagious, and that intramuscular and subcutaneous injections are useless to infect adult fowls. Hence this cannot be the natural mode of infection. nor was there any marked result from feeding the animals with infected food.

As the mortality from this disease amounts to 10 per cent., a more effective method was evidently required. This was found in lung infection ; for when fowls and rabbits were infected by injecting them in the trachea or the lungs, they rapidly succumbed. The author is led to conclude that it is probable that the natural mode of infection is through the air-passages.

## A METHOD FOR THE DETERMINATION OF FAT IN MILK.

(By C. L. Parsons : *Jour. anal. chem.*, iii, April, 1889.)

After unsuccessfully working with B. Röse's method of fat determination, the author discarded it and adopted the following : Eight to 10 grms. milk were weighed into a 250 c. c. pear-shaped flask, and heated to boiling over a flame. As soon as 212° F. were reached, 20 c. c. of 95 per cent. alcohol were at once added and the flask placed in a beaker of cold water. 100 c. c. of gasoline were placed in the flask after cooling, and shaken for one-half minute, after which a little less than one cubic centimetre of strong $NH_4OH$ was added, and the flask shaken for some time. The flask then stood quiet 15 minutes, when it was again shaken one minute. As soon as the gasoline fat solution separated and cleared up, 25 c. c. of the upper liquid were measured off with a pipette into a small tared flask, the gasoline distilled off and the fat dried at 100° C. to constant weight.

The amount of fat, multiplied by four gives the amount in the milk used ; the volume of the fat being so small in comparison to that of the solvent, it need not be taken into consideration excepting in cream analysis. The heating of the milk should be done as a precaution.

Forty-two determinations are given of comparative results from using the gravimetric and gasoline methods, on whole milk, the average amount of fat for all the gravimetric being 4.11 and of the gasoline 4.15 per cent. Twelve determinations are also given of mixed milk of several cows, four of skim milk, three of cream and three of buttermilk.

The author claims for the above method the advantages of Wanklyn's method for simplicity and nominal expense, and possessing greater accuracy.

### SACCHAROMEYCES LACTIS.

(By L. ADAMETZ: *Centr. f. Bakter. u. Parasit.*, v, 1889, pp. 116-20.)

This new torula, discovered by the author, is distinguished by the property it possesses of causing the fermentation of milk-sugar. The cells, which are elliptical or somewhat oval, are on the average 7 $\mu$ long and 5 $\mu$ broad. The buds, which are round, are 3 to 4 $\mu$ in diameter. Buds may form at either pole of a cell; sometimes two buds are produced at the same time. No ascospores were produced by cultivating on the gypsum block for 20 days at a temperature of 25° C. Account is given of the cultivation of this torula in pepton-gelatin, in wort-gelatin, in beer wort, and in milk. *S. lactis* causes fermentation of milk sooner or later, according to the temperature. At 40° the appearence of fermentation may be observed within 24 hours, at 38° in 48 hours, and at 25° C. in four days. No precipitation of paracasein occurs in the process, the milk-sugar only being decomposed.

*Ab.: Jour. roy. micros.soc., 1889, p. 426.*

## EXPERIMENT STATION ABSTRACTS.

### ANIMAL NUTRITION.

### SHORTS-BRAN AND CORN MEAL FOR FATTENING PIGS.

(By E. M. SHELTON: *Rep. Kansas board of agriculture, April, 1889.*)

These experiments were conducted at the Kansas experiment station.

Ten pure bred Berkshire pigs were used, in two different lots, though each pig was fed separately. The animals were full grown, though thin, when the experiment began. Pens one to five were fed a mixture of two parts shorts and one of bran. Pens six to ten received corn meal rather coarsely ground. The grain was given as a thick slop in both cases. Each pen contained a mixture of wood ashes, lime and salt, in a box; charcoal was also supplied.

The experiment extended from Oct. 8, 1888, to Jan. 28, 1889. The following table explains itself. The figures used refer to pounds.

FEED: SHORTS-BRAN.

| Pigs | No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | Tot'l |
|---|---|---|---|---|---|---|
| Weight Oct. 8 | 224 | 237 | 159 | 256 | 215 | 1,091 |
| Weight Jan. 28 | 444 | 445 | 396 | 432 | 420 | 2,137 |
| Gain | 220 | 208 | 237 | 176 | 205 | 1,046 |
| Total feed consumed by each pig | 1,109 | 1,129 | 1,148 | 1,067 | 1,144 | 5,597 |
| Am't. feed for 1 lb. increase of pig | 5.04 | 5.42 | 4.84 | 6.06 | 5.09 | |

FEED: CORNMEAL.

| Pigs | No. 6 | No. 7 | No. 8 | No. 9 | No. 10 | Tot'l |
|---|---|---|---|---|---|---|
| Weight Oct. 8 | 217 | 170 | 204 | 246 | 249 | 1,086 |
| Weight Jan. 28 | 485 | 392 | 423 | 443 | 487 | 2,230 |
| Gain | 268 | 222 | 219 | 197 | 238 | 1,144 |
| Total feed consumed by each pig | 1,288 | 1,317 | 1,131 | 1,229 | 1,267 | 6,243 |
| Am't feed for 1 lb. increase of pig | 4.80 | 5.93 | 5.16 | 6.23 | 5.32 | |

For lot one the gain per hundred weight of pig was 95 87 lbs., for lot two, 105.34 lbs. The average daily gain of lot one was 1.86 lbs., for lot two 2.03 lbs. The corn-fed pigs, ripened most rapidly, and drank the least water of the two lots.

The following table is of unusual interest, as showing the influence of food consumption as related to increase of growth and age:

| | Daily feed. | | Feed per cwt. of pig. | | Daily gain. | | Gain per cwt. of pig. | | Feed for each. lb. of increase. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Shorts-bran. | Corn-meal. | Shorts-bran. | Corn-meal. | Shorts-bran. | Corn-meal. | Shorts bran. | Corn-meal. | Shorts-bran. | Corn-meal. |
| 1st mo. | 9.04 | 10.52 | 25.25 | 29.62 | 2.31 | 2.42 | 7.42 | 7.80 | 3.90 | 4 35 |
| 2d " | 10.38 | 12.07 | 23.52 | 26.43 | 1.86 | 2.48 | 4.56 | 6.10 | 5.95 | 4.85 |
| 3d " | 10.70 | 11.72 | 20.40 | 20.88 | 1.78 | 2.08 | 3.58 | 3.91 | 5.98 | 5.61 |
| 4th " | 9.14 | 10.16 | 16.97 | 16.69 | 1.50 | 1.17 | 2.73 | 1.99 | 6.54 | 8.62 |

Comparing the vital parts, it is shown that with exception of spleen and kidneys, the advantage was always in favor of the shorts-bran series. They had more blood in proportion to a given weight of carcass, larger hearts, lungs, livers, etc., though this advantage was very small.

In breaking weight of bone, the breaking of Nos. one to five was preceded by no indications whatever, but broke off under a rather limited deflection, mostly with a clean, smooth fracture, lines drawn across the fractured surface being generally square across the bone. The fracture indicated a more granular and less fibrous character. Nos. six to 10 broke with a very irregular, flinty fracture, the surfaces showing sharp, irregular splinters.

There was no sensible difference in the amount of fat produced by the animals of either lot.

## COTTON SEED HULLS FOR FATTENING.

(*Arkansas agricultural experiment station. Bull. No. 9. pp. 1–15.*)

This is, we believe, the first bulletin yet issued upon this question. For some years the hulls of cotton seed have been used by practical cattle feeders for fattening cattle, with great success. One ton of seed yields about 36 gals. oil, 700 lbs. meal and 900 lbs. hulls. This station fed four animals one month with the following result:

| Animal. | Hulls eaten. | Cotton seed meal eaten. | Cost of food. | Effect of food in wt. | Profit or loss. |
|---|---|---|---|---|---|
| Bates.............. | 500 lbs. | 100 lbs. | $1.20 | 23 lbs. gain. | .40 c. loss. |
| William......... | 550 " | 110 " | 1.32 | 43 " " | .18 " gain. |
| Mary............ | 250 " | 50 " | .60 | 43 " loss. | 2.10 " loss. |
| Jane............... | 500 " | 100 " | 1.20 | 34 " gain. | .01 " " |

These figures are quite different from the claims of mill owners, who state that a gain of 75 lbs. per month per animal is customary.

Following is the mean of several of the station chemists' analyses of cotton seed hulls :

Moisture at 100° C., 10.05 per cent.
Dry matter.......... 89 95 "

ANALYSIS OF DRY MATTER.

| | | |
|---|---|---|
| Crude ash.................................... | 2.88 | per cent. |
| " cellulose.............................. | 49.36 | " |
| " fat.................................... | 1.60 | " |
| " protein.............................. | 3.85 | " |
| Non-nitogenous extract.. ............. | 42.31 | " |

## AGRICULTURAL PHYSICS.

### WASHING AND SALTING BUTTER.

(*Minnesota agricultural experiment station. Bull. No. 7, pp. 34–42.*)

To determine if salt would diffuse through butter, cups were filled with clear, fresh well-water, and covered over the tops with muslin cloths securely tied about them. The cloths were then covered with a solid layer of butter plastered one-fourth inch thick, and the cups then immersed in strong brine. At the expiration of a week no saltiness could be detected in the water in the cups. Other cups, similarly prepared, excepting that the butter layer on the muslin was but a mere film, and likewise placed in strong brine, gave the same results. Lard acted likewise. Butter laid upon the muslin, pressed when hard in a mould, and cut to one-fourth inch slices, passed no salt through, unless interstices existed between the granules large enough to be plainly seen with the naked eye.

Tests were made upon the question of salting butter with brine. Butter placed for 30 minutes in a very strong brine, absorbed only from 25 to 29 per cent. salt. Other samples of butter, in lots having both small and large granules, were stirred in strong brine, one, five and 30 minutes. The quantity of salt found in the small granules was .22, .28 and .31 per cent., and in the large granules, .13, .18 and .23 per cent. according as to the time of immersion being one, five or 30 minutes. Saturated brine, containing enough salt to show in flakes upon the surface, saturated the water in the butter by washing the latter when in a granular state. More salt can be incorporated into the butter if left 10 minutes in the brine, than if taken out sooner. If the churn is stopped when the butter granules are very small, brine salting may be accomplished most easily.

# VEGETABLE PHYSIOLOGY.

## FROSTED AND RUSTED WHEAT.

(*Minnesota agricultural experiment station. Bull. No. 7, pp. 77–84.*)

Analysis shows striking differences in normal wheat and that frosted and rusted. The percentages of protein and albuminoid nitrogen are high. The amount of protein in one case was as high as 20.19 per cent., the scale ranging down from this point. The albuminoid nitrogen varied from 2.13 to 2.88 per cent. The lowest per cent. of protein found in rusted and frosted seed was greater than the average of the graded seed, while it averages in the former two per cent. greater than in the latter. In the former the percentages of water and carbohydrates are less, while of ash, oil, fibre and protein they are greater. Carbohydrates decreased more than five per cent., while oil increased 1.5 and protein over two per cent. Unfortunately the author's references to his tables are not always correct.

## COMPOSITION OF CORN STALKS AND ENSILAGE.

(*Michigan agricultural experiment station. Bull. No. 49, pp. 3–7.*)

The plan adopted by Dr. Kedzie was to gather a specimen of corn as soon as it tasseled , make chemical analysis of part, and place the balance in the silo for future analysis. This operation was repeated each week till the corn was ripe. Burrill and Whitman ensilage dent, Hathaway, Breck's Boston market and white dent corns were used. The corn was in drills three feet nine inches apart, and one stalk on the average every ten inches in the row.

In the silo the crude fibre appeared to increase, because of loss of nitrogen-free extract from fermentation. A small loss of crude protein takes place in the silo, but the change from albuminoid to amide condition of the nitrogen compounds is the most striking feature of ensilage. There is a notable increase of ether extract in the ensilage, as compared with the stalks before ensiling. A marked increase of nitrogen-free extract occurs as the corn matures, while the acid decreases progressively in the ensilage. With maturity there is also a decrease in ash per cent.

## ON THE DETERMINATION OF HYGROSCOPIC WATER IN AIR-DRIED FODDERS.

(*Cornell university agricultural experiment station. Bull. No. 5, pp. 23–25.*)

Samples of hay, wheat bran and cotton-seed meal were pulverized as for a complete analysis. Ten methods of drying were adopted, viz.: (A) in watch glasses in boiling water bath, at 97° ; (B) in watch glass in air bath at 100° ; (C) similar to B, only temp. 110°–115°; (D) substance placed in a tube through which current of air was passed, tube being at 97° in water bath ; (E) treated as in D, only at 100° ; (F) similar to E, only at 110° ; (G) similar to D, dry hydrogen being used in place of air, at 97° ; (H) similar to G, at 100° ; (I) ditto G, at 110° ; (J) drying in vacuum, over sulfuric acid for 72 hours.

Three grams of substance were always used, samples cooled 30 minutes in desiccator before weighing. Complete drying followed during one hour, and reweighing. The results are as follows:

| | In open watch glass. | | | In tube, in current of dry air. | | | In tube, in current of dry hydrogen. | | | In vacuum. |
|---|---|---|---|---|---|---|---|---|---|---|
| | 97° | 100° | 110° | 97° | 100° | 110° | 97° | 100° | 110° | |
| | A | B | C | D | E | F | G | H | I | J |
| Hay | 8.39 | 9.46 | 12.93 | 8.87 | 9.81 | 12.26 | 8.52 | 9.75 | 10.40 | 9.58 |
| Bran | 7.73 | 8.13 | 8.31 | 8.59 | 8.54 | 8.71 | 7.90 | 8.02 | 8.91 | 8.02 |
| Cotton-seed meal | 6.78 | 7.89 | 7.91 | 7.29 | 8.16 | 8.11 | 7.02 | 8.03 | 8.43 | 7.98 |

The following conclusions are drawn:

(1) Raising the temperature raises the per centage of loss.

(2) The loss at 100° in an air bath corresponds closely to the loss in a vacuum.

(3) The effect of the temperature of 110° is greater in the determination on the hay, than on the bran and cotton seed meal.

## ECONOMIC ENTOMOLOGY.

### EXPERIMENTS IN REARING THE PLUM CURCULIO.

(*Indiana agricultural experiment station. Bull. No. 25, pp. 5-9.*)

Experiments were undertaken to learn if wild plums and cultivated species of native plums were proof from the plum curculio (*Conotrachelus nenuphar*). The fruit used was from various sources. The experiments were made by burying ordinary eight-inch tile vertically in the earth, the top projecting about an inch above the surface. The tile was filled with soil to within an inch of the top, including the sod where it was used. Fly screen was placed over the tile. Infested fruit was placed within the tile. The grass was allowed to grow in the sod. Nearly all of the curculios were above ground when the final examination took place. From 388 curculio punctured plums, 46 curculios were reared, or one to each 8.43 plums. Wild plums produced one for each 45 fruits; the wild goose one to each 31.5; the Robinson nearly one to every three. Cherries gave no adults in 10, crab apples none in 35, nectarines none in 11 and seedling apples one to four and eight-elevenths.

## AGRICULTURAL SCIENCE NEWS.

During 1888, £1934 were paid on the results of agricultural science teaching to England and Wales, £1862 to Ireland and £778 to Scotland.

Coumarin has been found by Molisch and Zeisel in *Ageratum Mexicanum*

(*Ber. d. Deutsch. botan. Gesell.*, vi, pp. 353-58.) The odor is not manifest till after the death of the plant.

The sixth annual convention of the association of official agricultural chemists will be held at the department of agriculture, Washington, commencing Sept. 10, 1889, at 10 A. M.

Samuel Johnson, for ten years professor of agriculture in the Michigan agricultural college has been deposed by the state board of agriculture, which has charge of the management of that college.

The government of the Cape of Good Hope is about to establish a college of agriculture at Grahamston. Mr. Archibald McDonald, a graduate of the Royal agricultural college, Cirencester, Eng., has been appointed tutor in agriculture.

Prof. J. H. Washburn, a graduate of the Mass. agri. college in 1878, later chemist to the Storrs agricultural school, and for the past two years at Göttingen, Germany, has been elected principal of the Rhode Island farm school.

Baudet and Adrian record in *Phar. Zeit.* (xxxiv, p. 23) the occurrence of morphine in *Escholtzia Californica.* Another base was also found, and a third substance, probably a glucoside. This plant has been used in this country as a substitute for opium.

According to *Nature* ( June 27, '89 ) at a recent meeting of the council of the university college of north Wales, it was decided to open an agricultural department at the college in October, and steps were taken to secure a lecturer in agriculture. The proposal to form dairy schools in connection with the university also met with favor.

Dr. H. Klebahn in *Hedwigia* (xxvii, pp. 305-6) describes the mode in which the spores of *Rhytisma acerinum*, a fungus parasitic on the maple are disseminated. The ascospores are about 65 $\mu$ long, and only 1.6 $\mu$ thick, so that they present a very large surface in proportion to their mass. They are surrounded also by a gelatinous envelope, by means of which they become firmly attached to the leaves on which they fall.

In the *Journal of agriculture* for June 27, is a most interesting three column article by Prof. J. W. Sanborn, regarding the misappropriation of funds for the Missouri agricultural college, and the investigation of that institution by the legislature. According to the statements therein made, the condition of affairs in Missouri in the management of the state university are shameful to the highest degree. Prof. Sanborn has been deposed.

The U. S. secretary of agriculture has appointed G. W. Hill, a well known agricultural editor, to establish a new division in the department, the function of which shall be to prepare careful resumés of the contents of the various reports andbulletins of the department. These briefs will be couched in as simple language as possible, without destroying the original value, and disseminated among the farmers of the country. The division will also prepare brief synopses of reports, etc., as issued, for the general press.

The June bulletin of miscellaneous information, published by the Royal gardens, at Kew, England, contains information relating to Jamaica cogwood, cocoa-nut coir from Lagos, a wheat pest in Cyprus, patchouli, P'u-Êrh tea and the agricultural industries at the Gambia. The July bulletin is of an exceedingly useful character, being a guide to the botanical literature of the British empire. The object of the compilation is to supply useful information on the literature of the systematic, economic and geographical botany of the possessions, dependencies and protectorates of the British empire.

# EXPERIMENT STATION ITEMS.

The grain plant louse is illustrated and described is bulletin 50 of the Michigan station.

Prof. Webster records (Bull. 25, Ind. exp. sta.) a strange case of two beetles. *Tenebrionides Mauritanica*, burrowing through a cork into a bottle of hellebore, and tunneling all through it.

The Massachusetts state station publishes what are apparently circulars, for May, June and July, giving analyses of commercial fertilizers, and the trade values of fertilizing ingredients.

Mr. F. G. Short, first assistant chemist at the Wisconsin station, has been appointed chemist to the Wisconsin dairy commission. Mr. F. W. A. Woll has been appointed as Mr. Short's successor.

The office of experiment stations of the U. S. department of agriculture, has just issued farmers' bulletin, number one. It is entitled "The what and why of agricultural experiment stations, and is explanatory of their work and what they have done."

Dr. Olaf Schwartzkopff, veterinarian to the Minnesota station, contributes an interesting article to bulletin seven of that station on "Modern feeding of pigs, and its influence upon the formation of the skull and dentition." The paper is well illustrated.

Bulletin four of the Georgia station is by the assistant chemist, C. Morton Strahan, and consists of analyses of cattle foods, with explanations of terms used. The following substances were analyzed: Mixed hay, wheat bran, cotton seed meal, cow pea vines, and sweet potato vines.

Household pests is the subject of bulletin five of the Hatch station of the Mass. agricultural college. The insects reported upon are *Anthrenus scrophulariæ*, L., *Attagenus piceus*, Oliv., *Dermestes lardarius*, L., *Tinia tapetzella*, L., *T. pellionella*, L., and *Tineola biselliella*, L. One page is given to ants.

A very creditable contribution to our knowledge of alfalfa occurs in bulletin eight of the Colorado station, in which its character, growth, composition and digestibility are touched upon. The analytical work is especially interesting, and demonstrates the high feeding value of this plant.

Dr. Detmers, veterinarian of the Ohio station, has published as bulletin two (vol. II) of the station a most comprehensive and excellent monograph on colic of horses. The matter presented is not new to science, but it is a discussion of the subject that cannot help but be of material benefit to the many farmers possessing horses who may see fit to refer to it.

Bulletin 63 of the North Carolina station devotes space to the tests of seeds with special reference to the vitality of old seed; rust on wheat and cotton; and analyses of fertilizers and marl. Mr. Dancy details a brief experiment upon the question as to whether stable manure loses any ammonia in drying. There was a loss in three weeks of drying equal to 3.36 per cent. of the ammonia originally present.

Bulletin 34 of the Massachusetts state station gives a meteorological summary; outline of work being carried on at the station this season; creamery record of the station during 1887 and 1888; analyses of commercial fertilizers; trade values of fertilizers, and contains a few circular notes by the department of vegetable physiology.

Bulletin No. 7 of the Minnesota station contains reports upon the following subjects: Soil temperatures. Comparison of varieties of corn for ensilage. Selection and cross-fertilization of corn. Washing and salting butter. Construction of greenhouse walls. Comparative tests of varieties of potatoes. The chemistry of wheat. Influence of food upon the growth of the skull and teeth of pigs.

Charbon is the title of the sixth bulletin of the Mississippi station, issued on account of that disease appearing recently in the state. Preventive treatment, symptoms of the disease and treatment are given in the one page paper. Bulletin seven describes a contest between hay presses on the station grounds. Four presses entered, viz.: the Ideal, Hunter, Hamilton and Lightning. The Ideal, made at Meridian, Miss., scored the most points.

Bulletin six of the Kansas station is upon silos and silage. The matter presented, though based upon experimental research to a large extent, is popularly written. The statement is made that 115 tons of silage fed during 1888–'89, carried 56 head of cattle 123 days, and that an average daily feed, with a small grain ration, was 34 lbs., or cubic foot. Of the 80 tons of fodder placed in one silo, 6.47 per cent. spoiled, caused largely by the yielding of the silo walls, less than one per cent. was rejected by the cattle and seven per cent. was lost by evaporation.

Bulletin 82 of the California station describes the wonderful changes undergone since 1880 by Kern and Tulare lakes. These are alkaline bodies of water. The area of water has been rapidly diminishing, while the alkalinity of the water has been as rapidly increasing. So alkaline has the water become, that, in Kern lake all fish and mussels were killed, while in Tulare lake the mussels and certain species of fish, notably cats and trout, were destroyed. In Tulare lake the solid contents increased from 81.80 parts, in 1880 to 303.07 in 1889, and soluble after evaporation 71.16 parts in 1880 to 279 97 in 1889.

An analysis of wheat screenings, consisting of broken, shrunken grain, chess, cockle, weed-seed, fragments of straw, chaff, etc., made by Dr. Kedzie, at the Michigan station, reported in bulletin 49, is as follows :

| | Sample one. | Sample two. |
|---|---|---|
| Water | 7.80 | 8.40 |
| Ash | 3.80 | 3.76 |
| Crude fibre | 4.95 | 6.10 |
| Crude protein | 14.78 | 15.06 |
| Ether extract--fat | 2.65 | 3.03 |
| Nitrogen-free extract | 66.02 | 63.65 |
| Nitrogen, total | 2.36 | 2.41 |
| Albuminoid nitrogen | 2.00 | 2.14 |
| Amide nitrogen | .36 | .27 |

Bulletin five of the Iowa station contains the results of original investigations upon sorghum by the station chemist, and a report upon important injurious insects by the entomologist. The latter portion is practically like most of the entomological bulletins on the same subject lately issued. The chemical work on sorghum related to increase of sugar per cent. produced by means of selection. Of 180 stalks analyzed, the ten best ones gave an average of 171 lbs. of available sugar by the new method, while the 10 next best produced but 156 lbs. In 32 stalks, the glucose ranged from 2.25 to 5.05 per cent. In comparing effect on available sugar by suckering and not suckering, the former had a decided advantage. Topping apparently produced no difference.

Bulletin 24 of the Indiana station is on milk production. The subjects are cold vs. warm water; divided milkings; studies on milk secretion. The results of giving dairy cows cold vs. warm water in winter, seemed to make no radical difference. Comparing the differences in fat per cent. of the first half with the last half of daily milkings, the latter exceeded the former by 43.55 per cent. The difference is very striking. A short study on milk secretion is given, and illustrated by drawings of the udder and milk vesicles. It is unfortunate that this bulletin should have been mailed with the conclusions of the first experiment terminating the studies on milk secretion.

AGRICULTURAL SCIENCE.

VOL. III. SEPTEMBER, 1889. NO. 9.

# THE CONTENTS OF SEED PACKAGES.

BY L. H. BAILEY.

Much is said concerning the dissemination of weeds in garden seeds, and there also appears to be a general impression that our seedsmen are careless as to the general contents of their packages. In order to determine how far these notions are true, a very careful series of examinations of packages have been made. A number of European samples, from Vilmorin-Andrieux et Cie. of Paris, have also been examined for indications as to the probable extent of introduction of weed seeds from the Old World. Incidentally, the reader will be able to glean some interesting figures from the table of results as to the numbers of seeds contained in packages.

The most harmful adulteration of seeds is that of mixing varieties, or of substituting inferior strains or varieties for good ones. But this adulteration cannot be detected by an examination of seeds, and is therefore difficult of control. The redress in this case must be demanded of the seedsman by the grower himself after the crop is grown. It is doubtful if the self-asserted irresponsibility of the seedsman, printed upon all seed packets, constitutes any legal immunity from damage in the case of harmful substitutions; at least, an English court has decided that such statement does not relieve the dealer. The fact that such instances so rarely come to our courts is proof that adulterations of this character are rare in this country.

## EXAMINATION OF SEED PACKAGES.

| Samples. | Seedsmen. | Quantity examined. | No. of apparently good seeds. | No. of impurities. | Per ct. of impurities, by number. | Weight of apparently good seeds. | Weight of impurities. | Per ct. of impurities by weight. | Nature of impurities. |
|---|---|---|---|---|---|---|---|---|---|
| Artichoke, *Vert de Provence* | Vilmorin ...... | 1 pkt. | 224 | 15 | 6.27 | 141 gr. | 3.25 gr. | 2.25 | 2 seeds of Bromus? ; remainder imperfect and broken seeds. |
| Artichoke, *Violet de Provence*.......... | Vilmorin ...... | “ | 233 | 21 | 8.27 | 147 gr. | 5.75 gr. | 3.76 | Imperfect and broken seeds. |
| Asparagus, *Barr's mamm'th* | Burpee ........ | “ | 239 | 4 | 6.46 | 77.25 gr | .75 gr. | .96 | Immature seeds. |
| Bean, *Extra large lima*...... | Cornish......... | “ | 30 | 1 | 3.22 | 1.7 oz. | 14.25 gr. | 1.88 | Broken bean. |
| Bean, *Extra early lima* ..... | Cornish......... | “ | 34 | 1 | 2.86 | 1 32 oz. | 5.25 gr. | .84 | Fragment of bean. |
| Bean, *Dreer's lima*............ | Cornish......... | “ | 31 | 0 | 0 | 1.46 oz. | 0 | 0 | .................................... |
| Bean, *Speckled lima*......... | Cornish......... | “ | 17 | 0 | 0 | 318 gr. | 0 | 0 | .................................... |
| Bean, *Challenger lima*....... | Cornish......... | “ | 25 | 0 | 0 | 1.045 oz. | 0 | 0 | .................................... |
| Bean, *Red lima*................ | Cornish......... | “ | 25 | 0 | 0 | 368.75 gr. | 0 | 0 | .................................... |
| Bean, *Lowe's champion*...... | Cornish......... | “ | 98 | 1 | 1.01 | 1.89 oz. | 6.5 gr. | .78 | Broken bean. |
| Bean, *Kentucky wonder*...... | Hoskins........ | “ | 138 | 0 | 0 | 2.22 oz. | 0 | 0 | .................................... |
| Bean, *Blue podded butter*.... | Burpee .......... | “ | 138 | 0 | 0 | 2.22 oz. | 0 | 0 | .................................... |
| Bean, *Improved lima*......... | Johnson & Stokes....... | “ | 49 | 0 | 0 | 1.6 oz. | 0 | 0 | .................................... |
| Bean, *Salem improved lima*.......................... | Johnson & Stokes ...... | “ | 29 | 0 | 0 | 1.42 oz. | 0 | 0 | .................................... |
| Bean, *Ford's mammoth podded lima*.................. | Johnson & Stokes....... | “ | 15 | 1 | 6.25 | 375.25 gr. | 16 gr. | .06 | Broken bean. |
| Bean, *King of the garden lima*.......................... | Johnson & Stokes....... | “ | 36 | 2 | 5.26 | 1.35 oz. | 27 gr. | 4.35 | Broken bean, and imperfect bean. |
| Bean, *New bush lima*........ | Henderson.... | “ | 24 | 0 | 0 | 121.75 gr. | 0 | 0 | .................................... |
| Bean, *Yosemite mam'thwax* | Henderson.... | “ | 13 | 0 | 0 | 131 gr. | 0 | 0 | .................................... |
| Bean, *Pride of Newtown*... | Thorburn...... | “ | 109 | 0 | 0 | 1.92 oz. | 0 | 0 | .................................... |
| Bean, *Kumerle's dwf. lima*. | Thorburn...... | “ | 26 | 0 | 0 | 359.25 gr. | 0 | 0 | .................................... |
| Bean, *Volger's kidney*....... | Thorburn...... | “ | 171 | 0 | 0 | 1.5 oz. | 0 | 0 | .................................... |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Bean, *Dwf. German black wax* | Burpee | 1 lb. | 1302 | 6 | .46 | 15.9 oz. | 13.25 gr. | .19 | ........ |
| Bean, *Early Mohawk* | Dept. agr. | 1 pkt. | 397 | 2 | .51 | 6.27 oz. | 7 gr. | .25 | Broken beans. |
| Beet, *Eclipse* | Dept. agr. | " | 1060 | 190 | 15.20 | 254 gr. | 16.5 gr. | 6.1 | 10 fragments of flower-stalks, 1 unknown seed; remainder small and imperfect beet fruits. |
| Beet, *Edward's extra early blood turnip* | Burpee | " | 322 | 26 | 7.47 | 87.25 gr. | 4.25 gr. | 4.64 | 5 fragments of flower stalks, 1 stone; remainder small and imperfect fruits. |
| Beet, *Osborn's selected* | Dept agr. | 1 pkt. | 1590 | 257 | 13.91 | 319 gr. | 22.5 gr. | 6.59 | 2 fragments of flower stalks, 1 morning glory seed, 3 wild buckwheat seeds (*Polygonum Convolvulus*), some litter; remainder small and imperfect fruits. |
| Beet, *Early flat bassano* | Henderson | 1 lb. | 20650 | 387 | 1.84 | 13.97 oz. | 95.25 gr. | 1.53 | Many large fragments of flower-stalks; remainder small and imperfect fruits. In addition, chaff and dirt, 36.75 gr. |
| Beet, *Swiss chard* | Henderson | 1 pkt. | 234 | 87 | 27.1 | 65.25 gr. | 7.5 gr. | 10.31 | 1 poppy capsule, 2 unknown seeds; remainder chaff and small and imperfect seeds. |
| Broccoli, *Early purple cape.* | Thorburn | " | 1115 | 6 | .54 | 57.25 gr. | .25 gr. | .43 | 1 grain of sand and 5 imperfect seeds. |
| Brussels sprouts, *Impr. dwf.* | Thorburn. | " | 1720 | 1 | .06 | 62.5 gr. | .02 gr. | .03 | Immature seed. |
| Cabbage, *Early sugar loaf.* | Dept. agr. | " | 1895 | 27 | 1.4 | 84.5 gr. | .5 gr. | .58 | Imperfect seeds. |
| Cabbage, *Conical head* | Dept. agr. | " | 1670 | 26 | 1 53 | 83.5 gr. | .5 gr. | .59 | 1 seed of Setaria?, 3 stones; remainder small and imperfect seeds. |
| Cabbage, *Marblehead mammoth* | Dept. agr. | " | 1728 | 11 | .63 | 87.25 gr. | 1 gr. | .11 | Immature and broken seeds. |

| Samples. | Seedsmen. | Quantity examined. | No. of apparently good seeds. | No. of impurities. | Per ct. of impurities, by number. | Weight of apparently good seeds. | Weight of impurities. | Per ct. of impurities by weight. | Nature of impurities. |
|---|---|---|---|---|---|---|---|---|---|
| Cabbage, *Early deep head*... | Cornish... ..... | 1 pkt. | 4850 | 120 | 2.41 | 204.25 gr. | 2.75 gr. | 1.35 | 9 onion seeds; remainder immature cabbage seeds. |
| Cabbage, *Late flat Dutch* ... | Thorburn...... | " | 1250 | 15 | 1.18 | 84.5 gr. | .5 gr. | .58 | ...................................... |
| Cardoon, *Plein inerme*...... | Vilmorin ...... | " | 205 | 9 | 4.21 | 159.25 gr. | 4 gr. | 2.45 | Broken seeds. |
| Cardoon, *de Tours* ........... | Vilmorin . .... | " | 215 | 21 | 8.89 | 145.75 gr. | 7.75 gr. | 5.05 | 3 unknown seeds, 1 stone; remainder broken seeds. |
| Carrot, *Early forcing*......... | Dept. agr... ... | " | 4240 | 350 | 7.84 | 58.5 gr. | 2 gr. | 3.31 | 3 stones, 1 unknown seed; remainder fragments of flower-stalks and imperfect seeds. In addition, dust, .5 gr. |
| Corn, *Perry's hybrid*.......... | Dept. agr...... | " | 632 | 15 | 2.32 | 4.9 oz. | 19.5 gr. | .9 | Small and imperfect kernels. |
| Corn, *Crosby*.................... | Dept. agr. .... | " | 703 | 44 | 5.89 | 5.32 oz. | 165 5 gr. | 6.64 | 1 fragment of cob; remainder small and imperfect kernels. |
| Corn, *Stowell's evergreen*... | Dept. agr...... | " | 718 | 9 | 1.24 | 4.84 oz. | 12 gr. | .56 | Small and imperfect kernels. |
| Corn, *Cory*...................... | Burpee ......... | " | 1205 | 33 | 2.66 | 11.16 oz. | 45.5 gr. | .92 | ...................................... |
| Cucumber, *White pearl*...... | Burpee ......... | " | 27 | 0 | 0 | 10.5 gr. | 0 | 0 | ...................... .............. |
| Cucumber, *Snake*.............. | Burpee ......... | " | 114 | 1 | .087 | 37 gr. | .125 gr. | .037 | Broken seed...................... |
| Cucumber, *Nichol's medium green*...................... | Dept. agr. ..... | " | 249 | 3 | 1.19 | 103.5 gr. | .5 gr. | .48 | Imperfect seeds. |
| Cucumber, *Setse Kiuri*...... | From Japan... | " | 220 | 0 | 0 | 68.25 gr. | 0 | 0 | ...................................... |
| Cucumber, *Dudaim*.. ........ | Vilmorin ...... | " | 238 | 2 | .83 | 64.5 gr. | .125 gr. | .19 | Bit of pulp? and an imperfect seed. |
| Dolichos *sesquipedalis* (Asparagus bean)............... | Vilmorin ...... | " | 405 | 3 | .74 | 907 gr. | 3 gr. | .33 | 1 seed of morning glory; 2 unripe seeds. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Dolichos —— (*Dolique de Cuba*.) | Vilmorin | 1 pkt. | 250 | 7 | 2.72 | 469 gr. | 1.5 gr. | .32 | Dirt, and 2 imperfect seeds. |
| Egg plant, *Violette longue hâtive* | Vilmorin | " | 1218 | 47 | 3.71 | 60.75 gr. | 1.25 gr. | 2.01 | 11 minute stones; remainder imperfect seeds. |
| Egg plant, *Ronde de Chine.* | Vilmorin | " | 694 | 35 | 4.80 | 45.25 gr. | .75 gr. | 1.63 | 5 unknown impurities; remainder imperfect seeds. |
| Egg plant, *Round white* | Thorburn | " | 731 | 2 | .27 | 45.25 gr. | .125 gr. | .28 | Imperfect seeds. |
| Egg plant, *Black Pekin* | Thorburn | " | 458 | 2 | .43 | 29 gr. | .02 gr. | .07 | 1 bit of pulp and 1 immature seed. |
| Egg plant, *Early long purple* | Henderson | " | 293 | 6 | 2.00 | 14 gr. | .25 gr. | 1.75 | 1 bit of pulp; remainder imperfect seeds. |
| Kale, *Frisé d' hiver* | Vilmorin | " | 3185 | 31 | .96 | 156.5 gr. | .06 gr. | .38 | 1 grain of sand; remainder small and imperfect seeds. |
| Kale, *Frisé panaché rouge* | Vilmorin | " | 1600 | 14 | .86 | 71.75 gr. | .25 gr. | .34 | Immature and broken seeds. |
| Kale, *Extra frisè demi-nain vert* | Vilmorin | " | 3665 | 6 | .16 | 146 gr. | .07 gr. | .05 | Imperfect seeds. |
| Kale, *Frisé rouge grand* | Vilmorin | " | 3783 | 53 | 1.38 | 187.5 gr. | .9 gr. | .47 | 1 grain of sand; remainder small and imperfect seeds. |
| Kale, *Frisé vert grand* | Vilmorin | " | 5800 | 38 | .65 | 179 gr. | .75 gr. | .41 | 2 grains of sand, 1 unknown seed; remainder small and imperfect seeds. |
| Kale, *Frisé vert à pied court* | Vilmorin | " | 5370 | 31 | .57 | 175 5 gr. | .4 gr. | .23 | 2 unknown seeds; remainder small and imperfect seeds. |
| Kale, *Cavalier* | Vilmorin | " | 7960 | 75 | .93 | 1 oz. 12 gr. | 1.5 gr. | .33 | 32 grains of sand; remainder small and imperfect seeds. |
| Kale, *Palmier* | Vilmorin | " | 1167 | 4 | .34 | 60 gr. | .05 gr. | .08 | Imperfect seeds. |
| Lettuce, *California cream butter* | Cornish | " | 1408 | 12 | .85 | 53.5 gr. | .125 gr. | .23 | ................................ |
| Lettuce, *Boston market* | Dept. Agr. | " | 2078 | 20 | .95 | 37 gr. | .25 gr. | .67 | Chaff, dirt, and flower buds. |
| Lettuce, *Royal cabbage improved* | Dept. Agr. | " | 1216 | 35 | 2.8 | 24 gr. | .5 gr. | 2.04 | ................................ |
| Onion, *Early red globe* | Cornish | " | 688 | 2 | .29 | 39.75 gr. | .125 gr. | .31 | Bits of stone. |

| Samples. | Seedsmen. | Quantity examnied. | No. of apparently good seeds. | No. of impurities | Per ct. of impurities, by number. | Weight of apparently good seeds. | Weight of impurities. | Per ct. of impurities by weight. | Nature of impurities. |
|---|---|---|---|---|---|---|---|---|---|
| Onion, *Giant blood red Rocca* .......................... | Dept. Agr ..... | 1 pkt. | 418 | 7 | 1.65 | 24.25 gr. | .25 gr. | 1.02 | 1 buckwheat seed, 1 immature seed, 5 unknown impurities. |
| Onion, *Welsh* or *Ciboule* (*Allium fistulosum*)....... | Vilmorin ...... | " | 750 | 25 | 3.23 | 38 gr. | .5 gr. | 1.29 | 2 seeds of Setaria?, a few immature seeds; remainder unknown dirt. |
| Pepper, *New ox-heart*.. ..... | Thorburn... ... | " | 258 | 2 | .77 | 35.75 gr. | .125 gr. | .35 | 1 immature seed, 1 bit of pulp. |
| Pepper, *Large squash*........ | Thorburn ...... | " | 318 | 26 | 7.56 | 39.25 gr. | 2 gr. | 4.85 | 2 bits of pulp; remainder immature seeds. |
| Pepper, *Squash or tomato shaped*.................. ..... | Henderson .... | " | 140 | 7 | 4.76 | 13.25 gr. | .25 gr. | 1.85 | Immature seeds. |
| Radish, *Black spanish*........ | Thorburn ...... | " | 1800 | 250 | 12.20 | 204 gr. | 9.75 gr. | 4.56 | 9 bits of stone, 10 unknown seeds, mostly evidently polygonums; remainder small and imperfect seeds. |
| Radish, *Early frame* ........ | Thorburn ...... | " | 275 | 20 | 6.77 | 59 gr | 1.5 gr. | 2.48 | Immature and imperfect seeds mostly. |
| Radish, *Half-long deep scarlet*.......................... | Thorburn ...... | " | 445 | 12 | 2.63 | 59.5 gr. | 1 gr. | 1.65 | Immature and imperfect seeds. |
| Spinach, *Bloomsdale*......... | Dept. Agr...... | " | 1249 | 37 | 2.87 | 170.1 gr. | 2.75 gr. | 1.59 | Flower stalks and imperfect fruits. |
| Spinach, *Bloomsdale*......... | Landreth....... | " | 1512 | 75 | 4.72 | 166.5 gr. | 2.5 gr. | 1.48 | 2 stones, 6 unknown seeds; remainder imperfect fruits. |
| Spinach, *Round leaved*.. ..... | Landreth....... | " | 1128 | 55 | 4.64 | 172.75 gr. | 1.5 gr. | .86 | Flower stalks and imperfect fruits. |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Spinach, *Round savoy-leaved* | Landreth | 1 pkt. | 1106 | 21 | 1.86 | 169.5 gr. | 1 gr. | .58 | 5 stones, 1 unknown seed, a little chaff; remainder imperfect fruits. |
| Spinach, *Monstrous viroflay* | Landreth | " | 1420 | 37 | 2.54 | 175 gr. | 3.25 gr. | 1.82 | 18 stones, 5 pieces of stem. 1 unknown seed; remainder imperfect fruits. |
| Spinach, *Prickly seeded* | Landreth | ¼ lb. | 10185 | 393 | 3.71 | 3.03 oz. | 28 gr. | 2.06 | 37 stones, some bits of stem, and imperfect fruits. |
| Tomato, *Tom Thumb* | Rawson | 1 pkt. | 875 | 14 | 1.57 | 42.5 gr. | .25 gr. | .58 | 1 bit of wood, 1 bit of pulp; remainder imperfect seeds. |
| Tomato, *King of the earlies* | Johnson & Stokes | " | 763 | 20 | 2.55 | 35.75 gr. | 4 gr. | 10.06 | 8 stones, 2 bits of pulp; remainder imperfect seeds. |
| Tomato, *Brandywine* | Johnson & Stokes | " | 477 | 5 | 1.04 | 24.75 gr. | .125 gr. | .5 | Imperfect seeds. |
| Tomato, *Optimus* | Ferry | " | 296 | 0 | 0 | 12.75 gr. | 0 | 0 | ........................ |
| Tomato, *New amber gem* | Morehouse & Annis | " | 780 | 4 | .51 | 28 gr. | .25 gr. | .88 | 1 piece of wood; remainder imperfect seeds. |
| Tomato, *Bay state* | Bragg | " | 192 | 5 | 2.54 | 10.75 gr. | .375 gr. | 3.35 | 1 poor seed, and pieces of pulp. |
| Tomato, *Green gage* | Thorburn | " | 500 | 25 | 4.76 | 18.25 gr. | .25 gr. | 1.35 | Imperfect seeds, and 1 bit of pulp. |
| Turnip, *Early six weeks* | Dept. Agr. | " | 4435 | 14 | .31 | 133.5 gr. | .25 gr. | .19 | ........................ |
| Turnip, *Bread stone* | Burpee | " | 3000 | 4 | .13 | 101 gr. | .05 gr. | .05 | Immature seeds. |
| Turnip, *American ruta baga* | Delano Moore | " | 4310 | 14 | .32 | .............. | .............. | .............. | ........................ |

### CONCLUSIONS.

1. There is no evidence of adulteration in any of the samples examined.

2. There are no hurtful impurities of appreciable amount.

3. The impurities are mostly of an unavoidable character, being incidental to the harvesting and preparation of the seed, as immature seeds, chaff, bits of stem, pulp, and the like.

4. The amount of unavoidable impurities is greater in some species than in others. The examinations show that impurities are greater in beets, artichokes, cardoons, spinach, and some peppers and radishes.

5. The per cent. by number of impurities, is greater than per cent. by weight, being in the average, 2.76 per cent. in the former case, and 1.38 in the latter. This difference is due to the fact that the impurities are mostly lighter than the good seeds, being largely immature seeds.

6. There are but four instances in which per cent. of impurities by number exceeds 10 per cent.: Eclipse beet from U. S. department of agriculture (15.20%); Osborn's selected beet from U. S. department of agriculture (13.91%); Swiss chard beet from Henderson (27.1%); Black Spanish radish from Thorburn (12.20%). These samples, and a few others, were not properly cleaned.

7. There are five instances in which per cent. of impurities by weight exceeds five per cent.: Osborn's selected beet from U. S. department of agriculture (6.59%); Swiss chard beet from Henderson (10.31%); Tours cardoon from Vilmorin (5.05%); Crosby corn from U. S. department of agriculture (6.64%); King of the earlies tomato from Johnson & Stokes (10.06%). These samples had not been properly cleaned.

8. In one-fifth of the samples there were foreign seeds, but they were in every case very few in number, and none of them appeared to belong to noxious species.

9. About ten per cent. of the samples were not properly cleaned from chaff, dirt, and similar impurities.

10. It appears, from the above, that there is no necessity for seed-control stations in this country for the purpose of preventing dishonest and careless introduction of foreign materials in the sale of garden seeds.

Cornell university agricultural experiment station,
Ithaca, N. Y., July, 1889.

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## ABSTRACTS.

### THE AMYLODEXTRIN OF NÄGELI AND ITS RELATION TO SOLUBLE STARCH.

(By H. T. Brown and G. H. Morris: *Jour. chem. soc.*, July 1889, p. 449.)

Amylodextrin, a name applied by Nägeli in 1874 to the product resulting from long continued digestion of starch with dilute mineral acids, has become well established in the literature. This substance was wholly soluble in hot water and crystallized in forms resembling the sphaero crystals of inulin. Nägeli regarded it as a distinct and separate body. Chemists who have given the matter attention of late have regarded the substance as identical with soluble starch, but the authors cited after a careful investigation arrive at a different conclusion.

The preparation of amylodextrin is as follows: Ungelatinised potato starch receives about six parts of twelve per cent. hydrochloric acid, and is allowed to digest in the cold for a considerable period; no visible action occurs until after about twenty days, when the granules begin to disintegrate, splitting parallel with their shortest perimeter. At the end of three or four months the disintegration is complete and the residue has lost nearly or all the original form of the starch grain. Meantime the reaction of the residual starch changes. The natural blue color with iodine becomes successively purple, reddish purple, reddish brown and finally yellowish red. It is probable that about six months are necessary for the completion of the action. A portion of starch treated this way during eight and a half years left about 60 per cent. of the original amount taken, as amylo-dextrin. The remaining 40 per cent. was shown to consist of dextrose. This amylodextrin is completely soluble in hot water, from which solution it is thrown down by alcohol as a fine white powder, which under the microscope has the form of sphaero-crystals. This in a pure state had a specific rotation $[\alpha]\, j + 206.25^\circ$, and a cupric reducing power of 9.07. These numbers correspond however to those which would result from a mixture of 14.87 per cent. maltose and 85.13

per cent. dextrin. To prove that the amylodextrin was not such a mixture, but a definite compound, was the object of the investigation. Its crystalline nature spoke already for its individuality. It was found to be absolutely unfermentable by active yeast. (*Saccharomyces cerevisiae*) indicating that its cupric reducing constituent could not exist as maltose.

It was impossible to separate it into two portions by fractional precipitation by alcohol.

Contrary to the observations of Nägeli it was found to be diffusable in the dialysator, and that portion which passed the membrane had the same qualities as the original substance which would not follow if a mixture of maltose and dextrin were treated.

These considerations justified the authors in pronouncing amylodextrin, a homogeneous compound of definite composition. They regard it as analogous to the malto-dextrin described by them previously, and as consisting of six dextrin groups united with one maltose group, the whole forming a complex.

$$\left\{\begin{matrix} C_{12}H_{22}O_{11} \\ (C_{12}H_{20}O_{10})_6 \end{matrix}\right\}$$

The calculated specific rotation and cupric reducing power of this, correspond to the actual data derived from amylo-dextrin. The molecular weight of such a compound (2286) corresponds also fairly well with that found by Raoult's method for amylo-dextrin, viz., 2220.

It was found to undergo rapid conversion into maltose under the action of diastase, differing however from the similar behavior of soluble starch in one respect. With the latter, there is an abrupt halt or resting place in the reaction, well shown by a graphic curve, but with amylo-dextrin the reaction proceeds uninterruptedly to its completion. It is evident from this therefore that the amylo-dextrin does not contain the highly stable dextrin nucleus which constitutes a fifth of the molecule of soluble starch and which is capable of resisting, temporarily, the action of diastase. Results of many determinations of material at different stages show that the amylo-dextrin is to be regarded as the final product of the action of cold dilute acids upon starch, of which the first step is formation of soluble starch, which by hydrolytic action is transformed into amylo-dextrin and dextrose.

W. E. S.

## WHAT MATERIAL BESIDE CARBON DI-OXIDE MAY SERVE FOR THE PRODUCTION OF STARCH IN GREEN PLANTS?

(By DR. TH. BOKORNY: *Die Landwirthschaftlichen Versuchs-Stationen*, xxxvi, p. 229.)

Artificial experiments upon this question, the results of which might throw light upon the process of assimilation, are all of modern date.

Boehm showed in 1883 that when leaves from which the starch has been removed, were laid in 10 to 20 per cent. sugar solution in the dark, starch soon appeared again in the chlorophyll grains. Other investigators following soon, found that leaves of a great variety of plants, indeed almost all, were able to form starch under the above conditions but in different degrees according to the kind of sugar used in the experiment. Lævulose gave good results with almost all leaves ; dextrose also but to a less degree ; cane sugar seems also to be available to most leaves, but favorable results from galactose were obtained in but a few cases. Leaves of *Dahlia variabilis* formed abundance of starch from maltose. Milk sugar was not available to leaves, but to potato sprouts. Raffinose and inosit both gave negative results. Two hexatomic alcohols, mannit and dulcit, gave positive results, but the tetratomic erythrit has so far proved unavailable.

Boehm it may be remarked, has lately proposed the theory that the observed phenomenon occurred at the expense of reserve sugar already contained in the cells, but made unavailable through lack of sufficient density in the cell sap, to satisfy the conditions of the physiological process. The sugar solutions in which the leaves were laid, supplied this density by osmose, and the processes were renewed. By using a solution of salts instead of sugar he succeeded in one case in producing small traces of starch in the leaves of one species (*Sedum spectabile*). But his experimental data seem deficient.

Dr. Bokorny has sought to extend our knowledge of the subject by experimenting with substances not belonging to this class of carbohydrates. Some doubtful experiments made by others with glycerine were repeated under different conditions. With very dilute solutions .1 to one per cent. of glycerine, starch formation was repeatedly proved in Spirogyra, Lemna and Cladophora. Further, he found that Spirogyra was able to avail itself of aethylenglycol for the formation of starch, and that certain other plants increase their dry substance in a solution of glycol. The greatest interest arises however over his experiments with formaldehyde because of the attention now directed to Baeyer's theory of assimilation, viz., the combination of water and carbon dioxide to formaldehyde ($CH_2O$) and its condensation to form a carbohydrate, $C_6 H_{12} O_6$.

Various experiments with solutions of .1 to one per cent. of formaldehyde, algae and leaves of various plants being placed therein, resulted in failure in every case. The formaldehyde was found to be fatal to all of them, and also to all the various fungoid forms which usually interfere with experiments of this sort. Even a solution of .01 per cent. strength proved fatal to many forms. These results certainly did not support Baeyer's theory. Still, the poisonous effect of formaldehyde is not necessarily an argument against this theory, since it is possible to prepare a solution which is so dilute as to be not harmful to the plant, and it is also possible that the process of condensation in the vegetable cell prevents any accumulation of formaldehyde beyond a certain harmless concentration. Loew has of late advanced the hypothesis that the formaldehyde as fast as produced in the cell, unites with the albumin of the same, and by a later reaction is released to form a carbohydrate. In either of the two latter cases, Baeyer's theory would not be untenable. The author sought for a substance therefore which was in itself not poisonous, but which could be easily decomposed, yielding formaldehyde; such a substance is methylal. $CH_3.O\text{-}CH_2\text{-}O.CH_3$. With this he was enabled to obtain positive results and prove that green vegetable cells are able to form starch from methylal. The explanation is that the latter is decomposed to formaldehyde and methylalcohol, and while it is possible as the author shows, for the latter to act as a nutrient, yet in the event of its presence in the solution as a product of decomposition, the formaldehyde must also accompany it, and in that case would act poisonously if not absorbed and transformed. As no such harmful action was observed it is assumed that formaldehyde as such was absorbed by the vegetable cell, (Spirogyra) which enabled it to form starch. This being true, it may be recognized as a support for Baeyer's theory of assimilation.

W. E. S.

## A NEW DISEASE OF THE IRISH POTATO: THE ANGUILLULE.

(By J. KUHN: *Bied. Centr.*, xvii, p. 842–5.)

It is probable that this malady has already been seen in many countries, where it has been confounded with the well known disease caused by phytophtora.

The harvest was being ripened in a field of Eos potatoes, notable for the large size of tubers, and it was seen that they were covered with spots more or less extensive. The spots when cut showed decay as in the ordinary potato disease, though in this case the change did not penetrate more than six, 10, or at most 13 m m. The brown spots were of less depth at the center than at the periphery, sometimes were whitish and of a *molle* and rough character. When numerous, they ran together, the surface was dark gray, wrinkled, much depressed at the healthy parts and often fissured. In the midst of the dark tissue, was seen white masses apparently consisting of starch grains, and often of round cavities, which were sometimes small and flattish or sometimes large. At this period the disease resembled dry rot. The stem end was more frequently attacked than the other parts.

The cause of the malady is an anguillule (Tylenchus) which under the microscope shows in all states of development males, females, asexual larvæ of different sizes and eggs containing embryos partly and completely formed. The anguillules of humus (Leptodera) penetrate into the potato where this parasite has opened the way, sometimes even going into the healthy parts.

The potato anguillule resembles in every way the *Tylenchus devastatrix* which the author discovered, in 1856, in the heads of cardoon, and which he identified as the same as the anguillule so injurious to rye, oats, buckwheat and clover.

As the anguillule had attacked only the Eos, of 16 varieties cultivated in the same field, it is nearly certain that it was introduced in the seed. In the very small spots on the tuber, are innumerable anguillules. It seems possible that the anguillules may, without leaving the plant, have passed from the tuber, by means of stolons, into new tubers, which would perhaps explain why the stem end is more often attacked than the rest of the potato.

The author counsels growers to avoid using diseased seed in planting.

*Ab.: Annales agronomiques, xv, pp. 333-4.*

## THE MANURING OF TURNIPS AND OATS.

(By DAVID WILSON, Jr.: From a lecture delivered to the Glasgow and west of Scotland agricultural discussion society.)

This lecture is a summary of results obtained upon the experimental grounds at Carbeth, Scotland, during the past eight years, made on a variety of soils. The land is pedigreed for the past ten years.

In 1882, '83, '84 and 85, 19 plats were grown to turnips on different fields, with simply barn yard manure, and 19 other adjacent plats with the same manure, excepting that they were given in addition ¾ cwt. nitrate soda or its equivalent ammonium sulfate. The average crop from the first series of plats, was 20 tons 12 cwt., from the other series 21 tons, 4 cwt. The use of potash salts with dung has been more unsatisfactory than the above. Twenty-two plats were treated with potash salts and barn yard manure, and 22 no potash, each series being grown for four years. The average yield with potash was 20 tons 13 cwt., without potash, 21 tons 9 cwt.

In growing turnips without the aid of barn manure, the author says that it will pay to use about one hundred weight of nitrate of soda per acre, as a top dressing. He does not advise using potash for turnips, unless on a soil on which it has previously been proven that its application pays.

Where no dung is given, phosphoric acid is the necessary manure for the turnip crop. With all the author's experiments, the average crop without superphosphate has been 7 tons 17 cwt. per acre; with eight hundred weight 25 per cent. superphosphate, 17 tons 19 cwt., an increase of more than 10 tons per acre.

Experiments comparing superphosphate with Thomas slag, favor the use of the former in turnip culture.

The result of the analysis of about 1,000 turnips grown at Carbeth, by different manures, shows that the feeding value of a turnip crop depends principally on its maturity—it should be fully ripe, but not pithy.

In oat experiments, the addition of potash to barn manure did not benefit the crop. Phosphatic manures alone were not beneficial except in increasing the weight per bushel. Nitrate of soda alone increased the crop, but not the weight per bushel; the crop was also later in ripening than when superphosphate was added with it. The manure which has proven most profitable in these experiments, begun in 1882, is three hundred weight of 25 per cent. superphosphate sown with the seed, and one hundred weight of nitrate of soda sown afterwards when the plants are about four inches high.

## ARSENICAL POISONS FOR THE PLUM AND PEACH CURCULIO.

(By S. A. FORBES: *Insect life*, ii, p. 3-7.)

The beetles in confinement ate the surfaces of plum leaves, especially the terminal ones, and also the green fruit, preferring the latter. Beetles captured April 14, before peach trees were in bloom, on dissection were found to have last fed on dead vegetation, though when beetles were confined with dead and living peach leaves, they ate only the latter. The beetle preferred the peach blossom to the fresh leaf to feed upon, both calyx and corolla being eaten from the edges. Rose and honeysuckle blossoms were also eaten with avidity by insects in confinement, but peony flowers were not touched after 10 days' exposure to the insect.

In testing insecticides, two lots of curculio were placed under glass, with leaves and green fruit of the plum, one lot being poisoned with one pound Paris green to 50 gallons water, the other not. All of the beetles fed on poisoned food soon died. Five out of six beetles were killed when the amount of water was reduced to 100 gallons. Five lots of beetles were experimented upon in May, 1889, Paris green being used on peach leaves sprayed once as follows: lot one, a check; two, one pound to one hundred gallons water; three, one pound to 200 gallons water; four, one pound to 300 gallons water, and five, one pound to 500 gallons water. Between May 6 and 14 all the beetles in lots two, three and four died, one of the checks died, and of 22 in lot five, one lived.

On May 17, London purple was tested upon 347 curculios divided into five lots, as in the case above, the only difference in treatment being the use of London purple. The numbers of insects used for the several lots are as follows in numerical order, 47, 100, 100, 50, 50. Ten of the check lot died, 92 of two, 89 of three, 41 of four and 45 of five.

## ACTION OF WATER CONTAINING SODIUM CHLORIDE ON SOILS AND PLANTS.

(By A. STOOD: *Landw. Versuchs-Stat.*, 1889, pp. 113–18.)

Water containing more than one gram of sodium chloride per litre damages vegetation, and even if the amount be only 0.5 gram, the germination of seeds is destroyed (33 per cent.) A further action which is also detrimental to plant growth is that by reaction of zeolites, tri-calcium phosphate, etc., with sodium chloride, the valuable constituents of these substances are rendered soluble and washed away out of reach of the plant, and this can occur when there is only 0.5 gram per litre. Districts, therefore, in which salt appears either in the water of irrigation or as underground or "bottom" water, cannot support plants in a healthy state, for apart from the solvent action of the sodium chloride, in warm weather it is carried up by capillarity to the upper parts of the soil, becoming there concentrated and so directly inimical to life. Analyses of soils thus affected show a large increase of sodium chloride, while the analyses of plants show not only increase of sodium chloride, chlorine, and total ash in the ash, but a decrease of potash and sulfuric acid.

*Ab.: Jour. chem. soc., 1889, p. 795.*

# EXPERIMENT STATION ABSTRACTS.

## ANIMAL NUTRITION.

### ON COTTON-SEED HULLS AND MEAL AS A FOOD FOR LIVE STOCK.

(*Tennessee agricultural experiment station. Bull. No. 3, 1889, pp. 45–56.*)

A number of instances are given of which enormous herds of cattle are fed upon cotton-seed hulls. The hulls consist of fragments of seed coats 1–16 to one-fourth inch in diameter, of dark brown color, very tough and leathery and entangled in a mass of cotton fibres which adhere to the outside of the hulls, left during the ginning process. While appearing unpalatable, these hulls are really much relished by cattle. No constipation results from the feeding, but rather the reverse. Scouring is cured by reducing the feed.

In fattening, steers are preferred to heifers. An average steer should receive at the beginning three or four pounds of meal daily, gradually increasing to six. After six weeks the feed may be increased to eight or 10 lbs.

In local dairies about Memphis, hulls have been fed as a substitute for hay for 12 or 15 years. In New Orleans the use of hulls is universal. The indications are that sheep can be profitably given this feed.

The composition of cotton-seed hulls depends upon the thoroughness with which the kernels are separated from them.

The following table is of interest:

| | Whole seed. | Hulls. | Hulls.[1] Average of other analyses. | Meats. | Meal. | Meal.[2] Average of other Analyses. |
|---|---|---|---|---|---|---|
| Moisture | 8.12 | 7.25 | 10.21 | 6.04 | 5.73 | 8.32 |
| Dry matter | 91.88 | 92.75 | 89,79 | 93.96 | 94.27 | 91.68 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Composition of dry matter. | | | | | | |
| Ash | 4.93 | 3.11 | 2.88 | 5.76 | 8.04 | 7.48 |
| Crude fibre | 22.70 | 46.18 | 48.22 | 3.29 | 5.49 | 6.20 |
| Fat | 22.07 | 1.66 | 2.22 | 38.94 | 12.45 | 14.58 |
| Crude protein | 22.58 | 4.04 | 4.59 | 35.18 | 47.21 | 46.23 |
| Non-nitrogenous extract matter. | 22.72 | 45.01 | 42.09 | 16.83 | 26.81 | 25.51 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

The digestible constituents of cotton-seed hulls and meal referred to wheat straw and linseed-cake as standards are as follows:

| | Cotton-seed hulls. | | | Cotton-seed meal. | | |
|---|---|---|---|---|---|---|
| | Perc'tage composition. (Pounds in 100 lbs.) | Per cent. constituents digestible. | Pounds digestible in 100 lbs. of hulls. | Percentage composition. (Pounds in 100 lbs.) | Per cent. constituents. digestible. | Pounds digestible in 100 lbs. of meal. |
| Moisture | 7.25 | ........... | ........... | 5.73 | ........... | ........... |
| Ash | 2.88 | ........... | ........... | 7.58 | ........... | ........... |
| Crude fibre | 42.83 | 52 | 21.71 | 5.18 | 26 | 1.35 |
| Fat | 1.54 | 27 | 0.42 | 11.74 | 91 | 10.68 |
| Crude protein | 3.75 | 26 | 0.98 | 44.50 | 87 | 38.72 |
| Non-nitrogenous extract matter | 41.75 | 40 | 16.70 | 25.27 | 91 | 23.00 |

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[1] One analysis in North Carolina experiment station, report 1882, two analyses in Massachusetts experiment station, report 1888, and average of several analyses in bulletin 9, Arkansas experiment station, 1889.

[2] Average of 29 American analyses compiled in Connecticut experiment station report for 1888. Part II.

A fattening animal of 1000 lbs. weight requires daily 2,5 lbs. protein, 15 lbs. non-nitrogenous extract and 0.5 lbs. fat, and a feed of 35 lbs. of hulls and 5.5 lbs. meal would closely approximate this demand. In practice, probably 25–35 lbs. of hulls and six to eight of meal daily would be the best ration.

The mineral elements of this feed pass largely into the manure.

## FEEDING EXPERIMENT.

(*Texas agricultural experiment station. Bull. No. 6, pp. 39.*)

Nine different pens of Texas steers of six animals each, were used in testing different feeding stuffs.

The foods used were as follows: pen one, silage, corn fodder, boiled cotton seed, cotton-seed meal; two, silage, cotton-seed meal and hay; three, silage, boiled cotton seed and hay; four, silage, raw cotton seed and hay; five, silage, cotton-seed meal, corn and cob meal, and hay; six, hulls, cotton-seed meal; seven, silage, hulls, cotton-seed meal and hay; eight, hay, corn in ear; nine, hay, corn in ear, out doors.

The animals in pens 1–8 were under shelter, and dehorned, while pen nine were out of doors and horned. Pen three gained at the least cost per pound, with pen four second. Pen nine made the least gain of all.

The aim of this test in one direction was to see if the common, unimproved Texas steer can be fattened with profit; in another to determine if sheltering range steers in winter feeding, will pay. The results show that the animals unsheltered made the least gain; and that 200 lbs. gain in weight may be made from $6.00 to $9.00 worth of silage, cotton-seed meal, cotton seed, and cotton-seed hulls, leaving a good margin for profit after deducting cost of labor, wear and tear of plant and use of capital.

The two tables below summarize the results:

| No. pen. | Average wt. cattle. | Pounds av. gain per 100 cwt. | Pounds av. gain per day. | Pounds av. total gain. | Av. cost of food per lb. gain. | Av. cost of food per head. |
|---|---|---|---|---|---|---|
| 1 | 724 | 17.7 | 2.67 | 128 | 3.14 cts. | $ 4.02 |
| 2 | 696 | 24.3 | 2.05 | 170 | 4.47 " | 7.61 |
| 3 | 777 | 22.2 | 2.08 | 173 | 2.85 " | 4.95 |
| 4 | 827 | 17.8 | 1.80 | 148 | 2.86 " | 4.22 |
| 5 | 808 | 24.4 | 2.37 | 197 | 5.00 " | 9.94 |
| 6 | 741 | 27.2 | 2.43 | 202 | 3.63 " | 7.31 |
| 7 | 722 | 24.6 | 2.20 | 178 | 3.93 " | 6.97 |
| 8 | 728 | 23.8 | 2.09 | 173 | 4.17 " | 7.23 |
| 9 | 876 | 18.0 | 1.90 | 158 | 6.83 " | 10.79 |

AVERAGE GAIN PER HEAD FROM FIRST. GAIN TO DATE FROM JAN. 1.

| No. pen. | Av. wt. at first. Jan. 8. | Jan. 14. | Jan. 17. | Jan. 21. | Jan. 24. | Jan. 28. | Jan. 31. | Feb. 4. | Feb. 8. | Feb. 25. | Mch. 11. | Mch. 31. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 724 | ...... | 5 | 8 | 32 | 45 | 60 | 62 | 79 | 128 | ......... | ......... |
| 2 | 696 | 12 | ...... | 12 | 27 | 44 | 59 | 65 | 72 | 122 | 138 | 170 |
| 3 | 777 | 16 | ...... | 15 | 41 | 51 | 61 | 64 | 79 | 146 | 161 | 173 |
| 4 | 827 | — 4 | —15 | —7 | 12 | 26 | 32 | 36 | 45 | 86 | 111 | 148 |
| 5 | 808 | —12 | — 8 | 11 | 27 | 35 | 53 | 43 | 69 | 127 | 153 | 197 |
| 6 | 741 | 3 | 15 | 44 | 35 | 52 | 62 | 64 | 86 | 118 | 171 | 202 |
| 7 | 722 | —30 | —20 | 4 | 21 | 40 | 37 | 45 | 71 | 123 | 153 | 177 |
| 8 | 728 | ...... | 6 | 11 | 15 | 14 | 25 | 20 | 45 | 111 | 134 | 173 |
| 9 | 876 | —20 | —18 | —6 | 13 | 7 | 11 | 23 | 26 | 89 | 117 | 158 |

## EXPERIMENTS IN PIG FEEDING.

(*Kentucky agricultural experiment station. Bull. No. 19, pp. 19.*)

Six Chester white pigs were divided into three lots, of two in each. Lot one received corn cob meal; lot two, corn meal and lot three shelled corn. The experiment lasted two months. The meal was always fed dry. The following table shows the effect of the feed:

| Pen. | Total weight. Jan. 21. | Total weight. March 25. | Gain. | Weight of grain eaten. | Gain in per ct. | Average gain of pigs per week. |
|---|---|---|---|---|---|---|
| 1 | 204 lbs. | 323 lbs. | 119 lbs. | 892 lbs. | 58 | 13.2 lbs. |
| 2 | 199 " | 374 " | 175 " | 753 " | 88 | 19.5 " |
| 3 | 199 " | 381 " | 182 " | 780 " | 92 | 20.2 " |

Other's hogs were fed the rations of lots two and three. Previous to this feeding they had been in another feeding test. In this test, shelled corn produced a gain of 11 per cent., while corn meal gave a gain of 25 per cent. However the corn was fed one week less than the meal.

A compound feed was given two pens composed of five thin rinds and one red Berkshire pig. Pen four received corn cob meal and pen five the same, with cotton seed, in the proportion of 2 to 1. At the end of one week the feed was changed by adding wheat bran to the ration. The ration of one lb. of cotton-seed meal, one of wheat bran and two of corn cob meal was given for 28 days, when ship stuff was substituted for cotton-seed meal.

In 56 days pen four gained 169½ lbs., or 41.8 per cent. on the original weight, and 1041 lbs. of corn cob meal were eaten. The average gain of the pigs per week was 21 lbs. With pen five, in seven days 7.5 lbs. or 1.8 per cent. were gained at a cost of 19.4 cents per pound. From Jan. 28 to Feb. 25, these pigs gained 46½ lbs., or 11.4 per cent. the original weight, at a cost of 13.7 cents per pounds. From Feb. 25 to March 18, a total loss of 4.5 lbs. occurred, a loss of 1.0 per cent. the original weight.

Further experiment with compound foods, showed that live weight steadily increased when fat forming foods were discontinued. Corn cob meal gave better results than mixed feed.

## POULTRY EXPERIMENTS.

(*N. Y. state agricultural experiment station. Seventh report, pp., 59-70.*)

Four pens of four pullets each were experimented with, being fed ground oats, water moistened, raw apples and Indian corn. Pen one contained light Brahmas; two, laced Wyandottes; three, S. C. W. Leghorns and four W. C. B. Polish. From January 23 to February 26 the fowls ate in ounces as follows:

| | Indian corn. | Raw apples. | Ground oats. | Total. |
|---|---|---|---|---|
| Larger breed | 3.06 | 2.32 | 1.27 | 6.65 |
| Smaller breed | 1.48 | 1.57 | .47 | 3.52 |

The birds gained steadily in each pen.

On March 1 four other pens of four pullets each, as follows, were placed under experiment: Pen one contained two Bramah and two Wyandottes; two, ditto; three, two Leghorns and two Polands, and four ditto. They were kept in pens 24x6 feet, and allowed to run in open yards after April 23. The table below, gives interesting data concerning the experiment, and shows what they were fed and ate:

| Pen. | Weight fowls Mch. 1. | Av. total food for six mo. eaten per day. | Each fowl averaged for entire period. | | | |
|---|---|---|---|---|---|---|
| | | | Linseed meal and bran. | Apples. | Potatoes. | Wheat. |
| 1 | 23lbs. 10¼ oz. | 3.60 ozs. | 252.25 ozs. | 83.25 ozs. | 36.0 ozs. | 291.0 ozs. |
| 2 | 24 " ¾ " | 3.60 " | 172.75 " | 55.50 " | 24.0 " | 220.75 " |
| | | | Corn meal. | | | |
| 3 | 12 " 2¼ " | 2.57 " | 252.25 ozs. | 83.25 " | 36.0 " | 291.0 " |
| 4 | 12 " 2¼ " | 2.55 " | 172.92 " | 55.50 " | 24.0 " | 217.58 " |

In egg production, the following results were secured:

| | Ratio of albuminoids to carbohydrates in feed. | No. eggs. | Total wt. grams. | Av. wt. one egg. grams. |
|---|---|---|---|---|
| Pen 1 | 1:3.7 | 12.50 | 688.63 | 55.01 |
| " 2 | 1:7.27 | 33.75 | 1878.73 | 55.67 |
| " 3 | 1:3.8 | 12.25 | 657.90 | 53.70 |
| " 4 | 1:7.24 | 41.42 | 2290.57 | 52.89 |

Pens one and two averaged 5.24 lbs. of manure per fowl during the feeding period, and pens three and four 2.46 lbs. The specific gravity of the eggs of pens three and four was very slightly higher than of those of pens one and two. The per cent. of shell in the eggs of pens one and two was a trifle less than pens three and four. The eggs of pens one and two lost 5.49 per cent. moisture, and pens three and four 4.49 per cent. in 30 days.

## THE FOOD OF CROWS.

(*By Walter B. Barrows: Report U. S. commissioner agriculture, 1888.*)

About 100 stomachs, mostly of adult crows, few of which were secured in spring or early summer, were examined. Of 86 stomachs containing vegetable matter, 35 contained kernels of corn, three oats, two wheat, 26 remains acorns or chestnuts, eight cherries (cultivated), 17 sumach seeds, 19 poison sumach and poison ivy seed. It is an interesting fact that the berries of the poison sumach (*Rhus venenata*) and poison ivy (*R. toxicodendron*) are eaten by the crow in large numbers.

Of 63 of 86 stomachs examined, 73 per cent. contained some insect food, the average amount in each of the 63 stomachs being nearly 20 per cent. the entire food. Ninety per cent. of the stomachs taken in December contained insects, while but 87.5 per cent. in July contained them.

## VEGETABLE PHYSIOLOGY.

### ON THE INFLUENCES OF CERTAIN CONDITIONS UPON THE SPROUTING OF SEEDS.

(*Cornell university agricultural experiment station. Bull. No. 7, pp. 29–71.*)

The following points are discussed from experimental data: 1. Influences of temperature upon sprouting. 2. Influences of varying amounts of water. 3. Influences of soaking seeds before sowing. 4. Influences of soil. 5. Influences of light. 6. Influences of weight of seed. 7. Influences of color of seed. 8. Influences of latitude. 9. Duplicate tests. 10. Comparisons of tests and actual plantings. 11. Impurities in samples.

Following we give the principal results from each test: (1) Different results are obtained from the same sample of seeds under variations of temperature, of which the daily mean is essentially the same. Sprouting occurs better at 74°, than under a variable temperature having about the same mean. Beans and peas sprout rapidly. Rapidity of sprouting diminishes with decrease of mean temperature. More rapid sprouting is not correlated with increased per cent. of total sprouting. Constant temperature (74°) does not appear to give greater percentages of sprouting.

(2) Sprouting is decidedly more rapid in tests which receive less water than is commonly used in greenhouses, with the per cent. usually greater in the dried tests. Extra water, over that necessary to keep the soil moist, is injurious. Wide differences between results of wet and moist tests, are not necessarily due to seeds rotting in the wet ones.

(3) Much time is gained through rapid sprouting, by soaking the seeds to a reasonable extent before planting. This time gain is fictitious, however, as germination actually begins in soaked seeds before dry samples are sown. Total sprouting does not appear to be influenced by soaking. Similar results are not to be expected from all species of plants.

(4) Variations in testing may be due to character of soil containing the seeds.

(5) Seeds exposed to light during sprouting may give very different results from those tested in darkness, indicating that light retards or prevents germination, according to the species. Apparatus which test seeds on porous plates may prove unsatisfactory, unless provided with an opaque covering.

(6) Seeds of different weights may vary as to rapidity of sprouting and total amount, and much more so with some species than

others. As a rule, the heaviest seeds give the earliest and best results. Heavy seeds, over ripe, in cases ripen later than light seeds and give poorer results. Under maturity may cause early germination, and such seeds are usually light.

(7) Seeds of different color in any sample, frequently give varying results under test, such as greater rapidity of sprouting or in higher total amounts. The relative values of seeds of different colors vary with each species or sometimes sample.

(8) Northern grown corn appears to germinate more quickly than southern grown.

(9) One test cannot be accepted as a true measure of any sample of seed. For duplicate tests, evener results are secured from a Geneva tester than from those made in soil.

(10) Actual planting in the field may give 50 per cent. less germinations, than those made under control.

## CONDITIONS AFFECTING THE DEVELOPMENT OF RUST ON WHEAT.

(*Indiana agricultural experiment station. Bull 20, pp. 15-19.*)

Attacks of rust are spontaneously induced by certain atmospheric conditions. Winter wheat sown upon stubble fields from which a crop of wheat or other small grain has just been taken, is particularly liable to an autumn attack from *Puccinia Rubigo-vera*. To get rid of the spores, the stubble should be burned over, and the old straw burned or completely rotted. White varieties are perhaps more susceptible to the disease than are red. Fulcaster, Egyptian and Dietz longberry varieties resist rust growth much better than most others. Velvet chaff is one of the most susceptible to the disease. Wheat rust is least effective upon well drained land. An excess of nitrogenous food in the soil seems likely to promote the disease. Analyses made of samples of plants free from rust, and slightly and badly rusted, seem to confirm the opinion that excessive soil nitrogen favors the disease.

## BACTERIA IN MILK AND ITS PRODUCTS.

(*Storrs school agricultural experiment station. Bull. No. 4, pp. 2-12.*)

Every one of 30 or 40 species of bacteria found floating in the air in the vicinity of Middletown, is found in cream and grows with the greatest facility in milk. None of the bacteria produce disease. Cream is a better bacteria producing medium, than milk, while butter is not a good one, though microbes were always found in it. Milk from a healthy cow has no bacteria, though if exposed but a few seconds to air becomes inoculated. In one drop of ripened cream from 10,000 to 100,000 bacteria have been found. *Bacillus acidi lactici* produces the ordinary souring of milk, and introduced into sterilized milk soon breaks up the milk sugar into either lactic or acetic acid and carbonic acid, causing the milk to curdle. *Oidium lactis* produces no important change in milk.

The bacteria, according to their action may be divided into four classes: (1) Some cause milk to sour as in the case of *B. acidi lactici* above noted. (2) Many produce the same results, only at higher temperature. At ordinary temperature they grow, but do not curdle the milk. (3) Some cannot break up milk sugar,produce no acid and do not coagulate the milk. (4) A few species curdle the milk, but produce no acid, the milk becoming alkaline instead. Experiments indicated the action in all these species somewhat similar, the details varying.

The curdling is very different in character, being perhaps hard with a clear liquid; or with no liquid, or the whole changing to a semi-gelatinous mass. Sometimes the curd breaks easily, while in other cases it is tenacious, sticky, etc.

The ripening of cream is a complex matter. The souring is apparently due to a process similar to the souring of milk; the thickening, in part to the milk curdling, and in part to the immense amount of bacteria in the cream. It is inferred that different kinds of bacteria assist in ripening cream.

## PLAT EXPERIMENTS.

### EFFECT OF FERTILIZERS UPON FODDER CORN.

(*Mass. state agricultural experiment station. Sixth report, 1888.*)

This experiment, which was begun in 1883, was undertaken to determine the effect of fertilizers upon fodder corn. The site of the plats is a wornout meadow. In 1883 and 1884 corn fodder was grown without the use of manures, showing that the soil was well exhausted, for in 1884 the entire crop of fodder with 30 per cent. moisture reached but 5.040 lbs.

The systematic treatment of the plats begun in 1885, and has continued since. There are 10 plats of one-tenth acre each, separated by spaces five feet wide. The entire field is surrounded by a tile drain, and each plat has a separate one through its center, which terminates in a well at the east ends, that is connected with the surrounding drain.

The plats were each plowed at the same time in the fall, after harvest, and in spring before manuring. The fertilizing materials were applied broad-cast and harrowed in slightly before planting.

The plats were treated as follows: (1) 50 lbs. muriate of potash (25 lbs. potassium oxide); (2) 50 lbs. nitrate soda (7–8 lbs. nitrogen); (3) 100 lbs. dissolved bone-black (16–17 lbs. soluble phos. acid); (4) nothing; (5) 97 lbs. magnesia sulfate; (6) nothing; (7) ditto plat one; (8) 50 lbs. sulfate ammonia (10 lbs. nitrogen); (9) ditto plat one; (10) 97 lbs. sulfate potash and magnesia (25 lbs. potassium oxide), 100 lbs. dissolved bone-black (16–17 lbs. soluble phos. acid). During 1885, 1886, 1887, plats 2, 4, 6 and 8 received no manures.

In 1885, 1886, 1887, plat 6 was not planted but was fallowed vegetation being killed by cultivation. In 1888, it was planted, like the others, though given no manure; during the larger part of the season its crop was the poorest looking upon the field.

The maize was planted in rows 39 inches apart, with six to eight seeds every 12–14 inches apart in the row.

The following table gives the principle results for 1887–88:

| | Hight plants when cut. | Weight stover. | Weight ears. | Yield dry fodder corn. | | Yield per acre. |
|---|---|---|---|---|---|---|
| | | | | 1887. | 1888. | 1888. |
| Plat 1 | 72 in. | 559 lbs. | 58 lbs. | 720 lbs. | 617 lbs. | 6,170 lbs. |
| “ 2 | 62 “ | 280 “ | 23 “ | 165 “ | 303 “ | 3,030 “ |
| “ 3 | 45 “ | 150 “ | 0 “ | 240 “ | 150 “ | 1,500 “ |
| “ 4 | 35 “ | 113 “ | 1 “ | 130 “ | 114 “ | 1,140 “ |
| “ 5 | 72 “ | 510 “ | 54 “ | 635 “ | 564 “ | 5,640 “ |
| “ 6 | 32 “ | 193 “ | 0 “ | —— “ | 193 “ | 1,930 “ |
| “ 7 | 74 “ | 626 “ | 50 “ | 730 “ | 676 “ | 6,760 “ |
| “ 8 | 29 “ | 141 “ | 5 “ | 165 “ | 146 “ | 1,460 “ |
| “ 9 | 63 “ | 487 “ | 66 “ | 655 “ | 553 “ | 5,530 “ |
| “ 10 | 84 “ | 607 “ | 130 “ | 940 “ | 737 “ | 7,370 “ |

## FUNGI AND FUNGICIDES.

### EXPERIMENTS WITH POTATOES CONCERNING SCAB.

(*Mass. state agricultural experiment station. Report for 1888.*)

The field the potatoes were grown upon, previous to 1885, was grown to grass. In 1885 corn was planted. In 1886 began experiments concerning scabby potatoes. The field was divided into five equal plats, 80 × 50 feet, with potatoes planted in rows 39 inches apart, and 36 inches apart in the row. The scabby potatoes used for seed were practically of a uniform size.

*1886 experiment.* Plat one was planted with untreated healthy and smooth tubers. Plat two planted with scabby seed allowed to remain 24 hours in saturated solution of muriate of potash. Plat three, seed scabby, treated to strong solution hypochlorite of lime as in case of two. Plat four, seed scabby, treated with saturated solution carbolic acid in water. The tops of all the plants were generally dead on Aug. 8. The yield was fair, and tubers of excellent quality without exception.

*1887 experiment.* The 1886 experiment was repeated upon the same land, with but a slight modification. Ten plats were planted, each 50 feet long, with four rows of tubers 39 inches apart. Medium sized, whole, beauty of Hebron, home grown potatoes were used for seed. The plats were planted as follows:

(1) Scabby seed, soaked in solution potassium sulfide
(2) “ “ without treatment.
(3) “ “ treated with solution hypochlorite of lime.
(4) Smooth seed, without previous treatment.
(5) Scabby seed, soaked in solution potassium chloride.
(6) “ “ without previous treatment.
(7) “ “ treated with solution carbolic acid.
(8) Smooth, healthy seed, not treated.
(9) Scabby seed, treated with copper sulfate.
(10) “ “ not treated.

The entire seed sprouted and produced good looking plants. The crop of plats 1, 2, 3, 5, 6, 7, 8 were not scabby, while plats 4, 9 and 10 were "somewhat."

*1888 experiments.* The work of 1888 was a duplicate of that of 1887. No marked differences could be detected in the appearance of the potatoes from the various plats, as all had produced some scabby tubers.

"The conclusion arrived at in previous years has evidently received an additional support by the results of the past season. Every one of our observations thus far made in this connection points towards the soil as the bearer of the cause of the scab on potatoes."

## EXPERIMENTS WITH FUNGICIDES UPON FRUITS.

(*N. Y. agricultural experiment station. Seventh report, pp. 153-7.*)

Potassium sulfide was used on the gooseberry mildew, and on the apple scab, was compared with soda hyposulfite and calcium sulfide. Solutions of one-half and one-fourth ounce to the gallon, respectively, of potassium sulfide, were sprayed at nine different periods, after hard rains, between May 3 and July 24, upon gooseberry plants affected with *Sphærotheca Morsuvæ*, B. and C., 287 plants being tested.

Towards midsummer the effect of the spraying was shown in the deep green foliage and rapid growth of the treated plants. On July 16, examination showed that in the row treated with half-ounce to gallon solution, only one plant exhibited mildew, while where the one-fourth ounce solution was used, but three plants were affected out of 43, and of 133 plants not treated, 15 were affected.

Soda hyposulfite contrasted with potassium sulfide and calcium sulfide for the apple scab, *Fusicladium dentriticum*, gave the following results. One half ounce of potassium sulfide was used in one gallon of water upon half of a crab apple tree (for two seasons sprayed with soda hyposulfite), eight times, after hard rains, between May 10 and July 24. More than 627 fruits did not mature on the unsprayed part, and 1560 were examined on the sprayed portion. The fruits were classified according to their quality, into three parts. Of the sprayed part of the tree, 75.9 per cent. of the fruit was first class, while but 46.9 per cent. of the unsprayed was first class. The results appear better for the potassium than the soda.

Ten fall pippin apple trees were treated with three solutions of compounds of sulphur, viz.: hyposulfite at rate of one ounce to ten gallons, potassium sulfide, half an ounce per gallon, and calcium sulfide in saturated solution.

The calcium did no good whatever, and it was not shown that, in this test, the potassium was a material improvement over the soda, though it contained much more sulphur than the soda hyposulfite.

# AGRICULTURAL SCIENCE NEWS.

The *New England homestead* for August 24, contains an excellent, full-page illustrated article on the Mass. agricultural college.

Miss Eleanor A. Ormerod has just privately published a small work entitled "Notes and descriptions of a few injurious farm and fruit insects of South Africa."

Prof. Edward M. Shelton of the Kansas agricultural college, and director of the station at that college, has been tendered and accepted the position of instructor in agriculture, in the Queensland, Australia, schools.

A new industrial agricultural educational bill, as it is called, has been presented to the British house of commons. The object is to provide instruction on agricultural and horticultural subjects in public elementary schools, and to afford practical illustration in such teaching.

Baron Felix Thümen of Görz, Austria, is to publish a work on the fungus diseases of cultivated plants, entitled "Die Pilzkrankheiten der Kulturgewächse." The work will contain colored engravings, specimens from the diseased plant and spores of the fungus. The maladies of agricultural plants, as well as those of the forest, vine, orchard and garden will be treated. It will be published in parts, about quarterly, at $1.25 each.

The trustees of the North Carolina college of agriculture and the mechanic arts, have elected the following members of the faculty: J. R. Chamberlain, of the N. C. station, professor of agriculture; W. F. Massey of the Miller manual labor school, professor of horticulture, arbor culture and botany; W. A. Withers, professor of chemistry; J. H. Kinelay, of Texas A. & M. college, professor of mathematics; D. H. Hill, professor of English and book-keeping.

According to the *American agriculturist* (August, '89) an agricultural school has been established by the government at Stellenbosch, Cape Colony, South Africa. The new institution will give attention to the theory and practice of the various branches of agriculture peculiar to that colony. The government viticulturist, tobacco expert and veterinary surgeon will be stationed at this school periodically, and an experiment station will be operated in connection with it. Students' board costs about $4 a week, everything included.

"Milk for cheese factories" is the subject of bulletin 41 of the Ontario agricultural college, by Prof. Robertson. In a practical way it offers advice concerning the feed, water, salt, shelter and milking of cows, with notes on the aeration, cooling and production of milk. "Notes for cheesemakers for July," by the same author, contain many pithy, short paragraphs of advice concerning treatment of cows, and milk for cheese. Bulletin 44 for August, is on the same subject by the same author, the notes however pertaining to the month of August.

# EXPERIMENT STATION ITEMS.

Bulletin five of the Nevada station, like the three preceeding, is a meteorological report.

Bulletin 10 of the Arkansas station gives notes upon the tarnished plant bug (*Lygus lineolaris*, Beauv.), chemical fertilizers and the state fertilizer laws.

Bulletin 20 of the Indiana station talks on "wheat rust," giving general notes on fungi, destructive capabilities of rust, the nature of wheat rust, wintering of rust, etc.

Bulletin 98 of the Connecticut station gives analyses of home-mixed fertilizers, and bulletin 99, fertilizer analysis. The value of home-mixed fertilizers is well brought out in bulletin 98.

"Commercial fertilizers" is the title of a serviceable bulletin for farmers published by the Kentucky station. Information of a general nature is given, with the state fertilizer law as an appendix.

C. L. Newman, late assistant in the university of Tennessee station, has been elected director of the north Alabama experiment station at Athens, and principal of the branch agricultural school at that place.

Bulletins four and five of the Maryland station are practically catalogues of the varieties of fruits, vegetables, grasses, etc., now being tested at the station. Bulletin five gives a few brief plans of the work in progress.

Analyses and valuations of complete fertilizers is the title of bulletin 56 of the New Jersey station. Special bulletin F. of the college station is upon the horn fly, and covers two pages, mainly in recommending tobacco insectcides to be used against this insect.

The "enemies of the wheat aphis," the subject of bulletin 51 of the Michigan station, are described and illustrated as the wheat louse parasite, lady bird beetles, syrphus flies and chrysopa flies. The parasites are briefly described with their methods of existence.

Prof. Edward D. Porter, recently professor of agriculture in the university of Minnesota, and director of the agricultural experiment station of the same, has been elected dean of the Missouri university college of agriculture and director of the experiment station, vice Prof. Sanborn.

Bulletin 23 of the Louisiana sugar station records experiments with the diffusion process during the 1888 season, with sugar cane. The matter is published largely in diary form, giving daily results, hence it is not presented in as comprehensive a form as many might wish. The use of sulfur dioxide as a clarifying agent was unsatisfactory.

The proceedings of the second annual convention of the association of American agricultural colleges and experiment stations is published by the office of experiment stations of the U. S. department of agriculture, and covers 123 pages. The report is full of interest, and contains a fund of useful information relating to station management.

J. Warne Phillips, D. Sc., has been elected chemist to the Nevada station, and professor of chemistry and physics in the Nevada state university. Fred. H. Hillman, B. Sc., has been elected entomologist and botanist to the station, and professor in the same studies in the university. W. S. Devol, B. Ag., is agriculturist and horticulturist to the station, and professor of agriculture and botany in the university.

The first annual report of the Rhode Island station and school, embracing 27 pages, is mainly historical, discussing the application of the Morrill land grant fund in Rhode Island and the Hatch fund. A map of the grounds of the institution is given. The station and school farm embraces 140 acres. A new building, to cost $10,000 is in course of construction, which will include chemical laboratory, office, etc.

The first annual report of the Maryland station covers about 30 pages. The director outlines what was accomplished by the station the first year, the horticulturist reports upon potato experiments, the chemist reports on his laboratory and analyses made, and the agriculturist discusses rotation plats, soya beans, the "unknown" cow pea, and stored ensilage. A record is made on the last page of methods of preparing and setting fence posts.

Bulletin five of the Delaware station is by Prof. F. D. Chester, the botanist, and relates to seed tests and germinations. Seeds were received from a number of sources in the state, and the tests show a better class of seed than farmers generally suppose to exist. Of 26 noxious species of weed seeds found, the plantain (*Plantago major*) heads the list.

Bulletin 20 of the Wisconsin station, which is upon the noxious weeds of the state, publishes the state laws regarding the destruction of weeds, and gives descriptions of and means of destroying the following species: *Cnicus arvensis*, *Arctium lappa*, *Chrysanthemum leucanthemum*, *Linaria vulgaris*, *Xanthium strumarium*, *Sonchus arvensis*, *Rumex crispus*, *Triticum repens*, *Chenopodium album*, *Capsella bursa-pastoris*, *Brassica Senapistrum*, *Convolvulus arvensis* and *Polygonum convolvulus*. There are 15 illustrations. This bulletin was prepared by Prof. E. S. Goff.

The first annual report of the New Hampshire station covers 104 pages. The director's report is largely a reproduction of bulletins one and four of the station. The report by the dairy superintendent is of interest, and will be referred to again in this journal. E. H. Harrington gives a paper upon fermenting bones, and C. L. Parsons describes his volumetric method for the estimation of fat in milk, etc., an abstract of which we gave, from another source, in the last number of this journal. A report of the microscopist, miscellaneous analyses, and appraisal list complete the contents.

First comptroller Mathews of the U. S. treasury, has decided that the appropriation of $600,000. made by the act of March 2, 1889, for "agricultural experiment stations," can be used for the benefit only of 40 stations for which estimates were made, viz.: $15,000. each for stations in each of the 38 states, in the territory of Dakota and at the U. S. agricultural department, and that no part of the appropriation can be used in the establishment of such stations in any of the territories with the exception of Dakota, that being the only one included in the estimates on which the appropriation was based.

Circular No. 12 of the office of experiment stations calls for bulletins and reports of experiment stations to complete files. It also gives a list of the publications of the office, up to July 30, this year. The office publishes five classes of documents. (1) Bulletins for station workers and others interested in agricultural science. (2) Farmer's bulletins, giving popular accounts of the main points in station work. (3) Miscellaneous bulletins, treating a variety of subjects. (4) Monographs on special topics in agricultural science. (5) Circulars, containing matter of transient or restricted importance. Three bulletins are at present in course of preparation. First, a digest of station bulletins. Second, two bulletins on pig feeding, prepared with the coöperation of Profs. Sanborn and Henry. Third, a monograph on the nutrition and feeding of domestic animals, in which it is proposed to summarize results of later European and American research. Profs. Armsby and Jordan, and Dr. Jenkins are assisting in this latter work.

Bulletin 16 of the New York state station, is upon maize and alfalfa as forage crops. The study of corn related to its value for ensilage. Burrell and Whitman corn was cut September 11 and 29. About 12 tons were cut in each lot, while in the watery or milky stage of kernel. In that of the 29th there is a gain of 22 lbs. of ash and 413 lbs. nitrogen-free extract, with no appreciable increase in albuminoids. There was a loss of amide nitrogen and gain of 16.75 lbs. albuminoid nitrogen. It is thought best not to cut the crop before it has reached the milk stage. Analyses of alfalfa at the station show that 15 tons of green fodder would be equal to 5.6 tons of hay per acre. Alfalfa appears much like red clover hay from analysis, with nearly as much albuminoids as wheat bran. In digestion experiment, in feeding alfalfa hay to cows, it appears that this plant is considerably more digestible than red clover, especially as concerns albuminoids and nitrogen-free extract. It is recommended to cut the plant in early bloom.

Of the $100,000 to be used during 1888 for sorghum sugar experiments, only $15,000 was used. As congress gave the U. S. department of agriculture permission to use the balance during 1889, for the same purpose, it will be expended at various points, as follows: Rio Grade, N. J., $7,500; Morrisville, Va., $3,500; Kenner, La., $5,000; Meade Center, Kan., $12,000, Conway Springs, Kan., $8,000; Attica, Kan., $6,000; Medicine Lodge, Kan., $6,000; Ness City, Kan., $4,000; Stirling, Kan., experiment station, $2,500; Cedar Falls, Iowa, experiment station, $5,000; general chemical control and direction, $15,000. One thousand dollars were reserved for experimenting with beet culture, and this amount will be divided between the stations at Madison, Wis., and Berkeley, Cal.

In view of the importance of the subject under discussion, we wish to call attention to the quotations below, concerning bulletin eight of the Missouri station, in which Prof. Sanborn concludes that corn ensilage is not superior to corn fodder as a feeding stuff. With these errors coming out so prominently, it is unfortunate that the bulletin was published, for these establish a lack of confidence in the accuracy of the entire work. Prof. Sanborn here and there through its pages apologizes for or explains errors in the work on which this bulletin is based. From these referred to errors we make the following quotations: "This material was not suitable for the trial, yet was fed with the results recorded in this bulletin," p. 4........"the above mentioned trials come nearest the mark..............The one I have to relate has faults of analyses," p. 5."........inasmuch as the chemist omitted the precaution of drying the ensilage on its receipt," p. 6. "By an oversight they were not weighed by the party in charge of the trial until Dec. 24, while the trial began Dec. 12," p. 13"........with all the errors and imperfections of the trial," p. 19. "The night's milk was not analyzed until the next morning," p. 22. "The details of the above trial were under the successful charge of........... who carried them forward with intelligence and care." Certainly with such evidence, this bulletin should not find a place in scientific discussion. Bulletin seven of this same station, according to Prof. Sanborn's remarks in the appendix, is likewise based upon much faulty work. Prof. Sanborn has won too high a reputation as an investigator to afford to allow such bulletins to have his name attached to them. Furthermore, our experiment stations cannot afford to publish work at all, unless those having it in charge believe it to be accurately done.

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Issued Sept. 24, 1889.

DEAR SIR :—

AGRICULTURAL SCIENCE is about to enter upon the fourth year of its existence. From the beginning it has sought to present to its readers, either as original contributions or in the form of abstracts, that work relating to the sciences underlying and as applied to agriculture, such as would serve as an aid in scientific investigation. Popular writing has never found a place in its pages, for the reason that that field is already occupied by ably edited agricultural journals.

Among those contributing original articles during 1889 may be mentioned the following: Dr. H. E. Stockbridge, director Indiana agricultural experiment station; E. S. Goff, professor of horticulture, University of Wisconsin; Prof. H. H. Harrington, chemist to Texas agricultural experiment station; Dr. H. W. Wiley, chemist to the United States department of agriculture; H. L. Bolley, of Purdue university botanical laboratory; F. W. A. Woll, of the Wisconsin agricultural experiment station chemical laboratory; Milton Whitney, professor of agriculture in South Carolina university and vice-director of the experiment station; Dr. E. Lewis Sturtevant, late director of the New York state agricultural experiment station; Dr. W. E. Stone, chemist to the Tennessee agricultural experiment station; Dr. H. P. Armsby, director of Pennsylvania agricultural experiment station; J. B. Harrison, chemist to Government laboratory, Barbados, West Indies, and others.

The foreign subscription list has steadily gained from the first, so that at the present time it extends pretty well over Europe, as well as to Japan and the West Indies, while its original contributions are being translated into prominent scientific journals abroad. Consequently, as it also goes into nearly every experiment station in America, it furnishes the best kind of a medium for those persons who wish to submit scientific papers on agriculture to the largest and most appreciative audience.

You are cordially invited to do what you can to aid in increasing the effectiveness of this journal, either by subscriptions or publishing in its pages original contributions. Foreign subscribers are also invited to favor the magazine with contributions, which will be printed either in French or German.

A few back volumes are for sale as follows: Vol. I, of nearly 300 pages, $3.00; vol. II, of 351 pages, $2.50 and vol. III, $2.50, post paid.

As there is no other journal in the English language of this kind, you cannot be well informed as to the work done in America, as well as that published in foreign journals, unless you have this magazine. Address, C. S. PLUMB,

University of Tennessee,
Knoxville, Tenn., U. S. A.

AGRICULTURAL SCIENCE.

VOL. III. OCTOBER, 1889. NO. 10.

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# THE CHEMICAL COMPOSITION OF CULTIVATED STRAWBERRIES.

BY W. E. STONE.

The marked absence of references to the composition of our native wild or cultivated fruits, in the American literature of agricultural chemistry, is the reason for recording in these pages the following, somewhat condensed results of an examination of twenty varieties of cultivated strawberries.

In passing it seems not out of place to regret this neglect of a field of investigation which offers promising results. The improvement which small fruits have undergone in all their qualities is notorious. Taste and flavor are essentially dependent upon or rather indices of chemical composition, and that the latter may be markedly influenced is shown by a series of experiments upon grapes conducted at the Massachusetts agricultural college during the years 1876 and 1877[1].

It is reasonable to believe that a systematic study would show that the composition of all our fruits, particularly those classed as "small," might be greatly influenced by special fertilization, as well as by variation of other conditions. Preliminary to such work, however, we have almost no data indicating what an average or normal composition of our fruits may be, neither any fixed point from which we may measure the present or subsequent improvement of varieties. From this standpoint, the results presented here may be of interest.

The samples for the following determinations ripened and were collected during the last week of May, of the present season. Immediately upon its receipt at the laboratory, the fresh fruit was "hulled" (freed from the involucre); one portion was dried for later determinations, and the other served for the estimation of water and solids, sugar and free acids. Difficulty was experienced in drying the samples, owing to behavior of the fruit toward heat, the tissues collapsing and the juices flowing out at 50° to 60° C.; on this account the samples for analysis were dried in the sunshine. The determinations of water and solids were made in 15 to 20 grams of the fruit, sliced into tared beakers, and dried first at 98° C., and later at 105° C., until an approximately constant weight was obtained. The samples dried in the sunshine had the consistency of dried figs, or raisins, and contained about 20 per cent. of moisture. Their taste was remarkably like that of figs. If cured by a method similar to that followed with figs or raisins, the strawberry would produce a novel and agreeable "sweet," although the difficulty of rapidly and cheaply drying the fresh fruit would doubtless be an obstacle to the economy of the process.

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[1] See report of Massachusetts state board of agriculture, 1879--1880; also résumé of analyses in report of Mass. state ag'l. experiment station for 1888.

Sugar and free acid were determined in a solution of the juices of the fresh fruit, made by thoroughly crushing a weighed quantity (80 to 100 grams) in a mortar, transferring the mass without loss to a flask, and increasing the volume to 350 c. c., thorough shaking and filtration after 15 minutes. Sugar was estimated by titration, with Fehling's solution, before and after inversion ; free acid by titration, with tenth-normal potassium hydrate.

The following results are the averages in each case of two or more determinations :

| Varieties. | Water. | Solids. | Free acid. (Malic.) | Glucose. | Glucose after inversion. | Difference calculated as cane sugar. | Composition of dry matter. | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Ash. | Crude fibre. | Ether extract. | Crude protein. | Non-nitrogenous extract. |
| Indiana | 91.51 | 8.49 | 1.38 | 4.41 | 5.31 | 0.86 | 7.22 | 14.90 | 6.46 | 12.17 | 59.25 |
| Jumbo | 90.83 | 9.17 | 1.37 | 3.91 | 4.81 | 0.86 | 6.01 | 14.92 | 6.60 | 10.41 | 62.06 |
| May king | 90.13 | 9.87 | 1.18 | 5.25 | 6 03 | 0.74 | 6.74 | 14.41 | 6.26 | 11.19 | 61.40 |
| Agriculturist | 91.25 | 8.75 | 1.24 | 4.05 | 5.21 | 1.10 | 6.66 | 13.46 | 7.07 | 11.17 | 61.64 |
| Cornelia | 90.42 | 9.58 | 1.05 | 4.30 | 5.12 | 0.78 | 6.56 | 16.06 | 4.97 | 9.83 | 62.58 |
| Legal tender | 90.29 | 9.77 | 1.48 | 6.71 | 6.73 | 0.02 | 6.33 | 13.71 | 6.41 | 10.17 | 63.38 |
| James Vick | 89.68 | 10.32 | 1.34 | 4.41 | 5.63 | 1.17 | 6.01 | 17.89 | 6.74 | 9.53 | 69.73 |
| Iron clad | 89.58 | 10.42 | 1.74 | 4.76 | 5.81 | 1.00 | —— | —— | —— | —— | —— |
| Perry | 91.03 | 8.97 | 1.47 | 4 75 | 4.94 | 0.18 | 6.12 | 11.54 | 5.86 | 9.45 | 73.03 |
| Bidwell | 89.43 | 10.57 | 1.56 | 4.28 | 5.06 | 0.74 | 6.41 | 18.80 | 8.07 | 11.66 | 55.06 |
| Primo | 89.98 | 10.02 | 1.57 | 4.89 | 5.16 | 0.26 | 6.86 | 16.77 | 6.92 | 10.88 | 58.57 |
| Mt. Vernon | 91.26 | 8.74 | 1.22 | 5.08 | 5.20 | 0.11 | —— | —— | —— | —— | —— |
| Nameless | 92 43 | 7.57 | 1.30 | 5.13 | 5.40 | 0.26 | 5.79 | 19.17 | 8.31 | 9.99 | 56.74 |
| Mrs. Garfield | 91.22 | 8 78 | 1 24 | 5.73 | 6.52 | 0.75 | 6.55 | 14.52 | 6.44 | 10.76 | 61.73 |
| Kentucky | 87.72 | 12.28 | 1.90 | 5.77 | 6.59 | 0.68 | 5.92 | 13.41 | 7.39 | 8.24 | 65.04 |
| Jucunda | 90.44 | 9.56 | 1.42 | 4 93 | 6.08 | 1.09 | 7.62 | 23.71 | 8.38 | 11.30 | 48.99 |
| Perry's seedling | 89.71 | 10 21 | 1.45 | 4.16 | 4.95 | 0.75 | 7.95 | 17.46 | 4.99 | 10.76 | 58.84 |
| Boone | 91.35 | 8.65 | 1.07 | 4.33 | 4.39 | 0.05 | 8.07 | 22.71 | 9.12 | 10.16 | 49.94 |
| Manchester | 91.05 | 8.95 | 1.36 | 4.83 | 5.39 | 0.44 | 4.16 | 14.53 | 4.81 | 10.98 | 65.52 |
| Woodruff | 91.14 | 8.86 | 1.09 | 3.98 | 4.84 | 0 82 | —— | —— | —— | —— | —— |
| Means | 90.52 | 9.48 | 1.37 | 4.78 | 5.46 | 0.58 | 6.53 | 16.35 | 6.75 | 10.51 | 60.79 |

The predominating acid of the strawberry seems to be malic, from careful qualitative tests of the material at hand. No trace of tartaric acid was recognized; if citric acid is present or not, is rather uncertain, but if so, it exists only in small quantities. The amount of free acid in the different sorts varies slightly, altogether within limits of one per cent. The amount of glucose shows a somewhat greater variation. The increase of glucose by inversion is only slight, and for convenience is recalculated as cane sugar.[1] We believe however, that cane sugar does not exist in the strawberry, basing the conclusion upon the following reasons: 1. The amount of free acid present would tend to convert any cane sugar which might be formed into glucose. 2. The presence of other substances such as gums, pectose matter, etc., would account for the slight increase of glucose after inversion. 3. Direct attempts to separate cane sugar from both fruit and juice by extraction with hot alcohol and subsequent crystallization, as also by the strontium oxide method (see *Die Landw. Versuch-Stationen*, xxxiv, p. 408) failed to give even a trace of the sugar sought.

In considering the relative percentages of the food constituents, it should be borne in mind that the seeds are included in the data given. Their presence would probably tend to increase the proportions of ash, fibre, ether extract and protein, and lessen that of the nitrogen-free extract.

The average of European analyses of 33 varieties of strawberries all made previous to 1868, and varying widely among each other, shows[2]: water 87.66 per cent., total glucose 6.28 per cent., free acid 0.93 per cent.; in dry substance, protein 4.63 per cent., cellulose, 18.79 per cent., ash 6.56 per cent., according to which the European berry contains more sugar and less acid, also less protein and more fiber than the American sorts investigated. Unfortunately, circumstances did not permit a simultaneous examination of the wild strawberry. In this respect it would have been particularly interesting to note the changes in the relative proportions of sugar and acid produced by cultivation. In the cultivated varieties examined, the acid was to actual glucose as 1 to 3.5 or, if we admit the presence of cane sugar, somewhat higher. The only references to native wild strawberries available, give the proportion of acid to sugar in the same as 1 to 2.[3] In the European analyses already referred to the remarkable proportion of 1 to 9 or more is given. This proportion of acid to sugar must decide largely the desirability of any particular variety, other things being equal, and is one of the chief points to be sought for in improvement.

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[1] The titrations were made according to Soxhlet's method. Ten c. c. of Fehling's solution were diluted with two volumes of water, and brought to a boiling temperature. The dilute sugar solution was then run in from a burette, and the whole boiled for two minutes. Usually four or five trials were sufficient to fix the exact result. Inversion was secured by treating 50 c. c. of the original solution with 5 c. c. concentrated hydrochloric acid during one-half hour, at 65° C., neutralization, addition of water to 100 c. c. followed by titration with Fehling's solution.

[2] Chemie d. Mensch. Nahrungs u. Genussmittel, J. König, I Band, 3d edition, 1889, p. 777.

[3] C. A. Goessmann. Report Mass. state board of agriculture, 1879-1880. H. A. Weber, Journal Columbus horticultural society, June, 1887.

Tennessee agricultural experiment station,
Knoxville, Sept., 1889.

## ON A NEW SELF-REGISTERING SOIL THERMOMETER.

BY MILTON WHITNEY.

The writer has been trying for several years to find a thermometer for taking the temperature of the soil, which would be less expensive, require less attention and especially require less tabulation and calculation, than the present form, and at the same time give definite information on the actual range of temperature. Various methods were considered, and correspondence and personal conference with some of the leading instrument makers and meteorological societies of this country and abroad failed to suggest a form of instrument which would meet our requirements.

We have at last devised a modification of Six's form of thermometer, in which the maximum and minimum temperature are registered in one and the same instrument. The essential features of the thermometers are as follows: a cylindrical bulb six inches long, filled with alcohol. The bulb is protected by a somewhat larger cylindrical metal tube, containing numerous holes, and is to be placed three inches below the surface of the soil, *i. e.*, so that the bulb will extent from three to nine inches in depth of the soil. The tube carrying the alcohol extends some six or eight inches above the surface of the ground, when it bends twice at right angles and descends again to the surface, bends twice at right angles crossing the main stem, and is carried up about six or eight inches again, where it terminates in a bulb partially filled with alcohol. The lower bend in this stem carries a column of mercury which is drawn back towards the bulb when the alcohol contracts, and pushes a steel index up to the minimum temperature on a scale, which reads downward. The index is held supported in the alcohol by a little spring, when the alcohol expands and the mercury leaves it, while another index is pushed up to the maximum temperature by the other end of the column of mercury. The indices are set with a magnet.

The advantages claimed for this instrument are that it gives at once, without any calculation, the mean temperature of a definite depth of soil, for which we now use at least three thermometers, while it gives in addition the maximum and minimum temperatures and need only be read once a day instead of three times as at present. The readings of our instrument agree so far very well with the mean of the three, six and nine-inch thermometers of the usual form, a few inches away in the same soil, as will be seen from the table.

| Date. | Mean temperature of soil 3-9 inches deep. | | |
|---|---|---|---|
| | Six's. | Mean, 3-6-9. | Difference. |
| May 23, 1 P. M. | 81.5 | 81.5 | 0.0 |
| “ 7 “ | 85.0 | 86.3 | —1.3 |
| Mean daily | 77.7 | 78.9 | —1.2 |
| May 24, 7 A. M. | 71.0 | 71.2 | —0.2 |
| “ 1 P. M. | 87.5 | 85.0 | +2.5 |
| “ 7 “ | 89.0 | 89.2 | —0.2 |
| Mean daily | 81.5 | 81.4 | +0.1 |
| May 25, 7 A. M. | 75.5 | 75.7 | —0.2 |
| “ 1 P. M. | 89.3 | 87.1 | +2.2 |
| “ 7 “ | 89.1 | 89.6 | —0.5 |
| Mean daily | 84.0 | 84.1 | —0.1 |
| May 26, 7 A. M. | 74.0 | 74.8 | —0.8 |
| “ 1 P. M. | 90.0 | 89.1 | +0.9 |
| “ 7 “ | 85.7 | 87.1 | —1.4 |
| Mean daily | 84.6 | 83.7 | +0.9 |
| Mean | 83.0 | 83.0 | 0.0 |

These actual differences are no greater than occur between duplicate sets of thermometers side by side in soil of the same character. Thermometers can be made of course with bulbs longer or shorter than the one described. We adopted the length of six inches placed three inches below the surface, as in our experience that represents a layer of soil in which most of the roots of the cotton plants are contained. We expect to distribute a number of these instruments through the state, and have records kept near signal service stations, and have records kept for us in our typical soils—a method which could hardly have been arranged with the old form. The instrument is mounted on a neat metal backing, and was made by H. J. Green of New York. It cost $10 without packing or express charges. The great trouble about the instrument is the danger in transportation, of having the index get down into the mercury column. For this reason it has to be transported in a box on gimbals to swing freely within a larger box, so that it will always remain upright. We had such a box made capable of carrying eight or ten instruments, for $5.00.

South Carolina agricultural experiment station,
Columbia, May, 1889.

# LETTERS TO THE EDITOR.

## ON THE COMBINATION OF INSECTICIDES AND FUNGICIDES.

An important advance that must soon be made in saving to the soil-tiller the fruits of his labor, is that of so combining the preventives of insects injury with the preventives of rusts, smuts, blights, and the various other injurious fungi, that both may be applied at the same time and in the same mixture. Heretofore the entomologists have worked out the remedies for insects, and the botanists the remedies for fungous diseases, but very little has been done in so combining the treatment that the practical man may, so to speak, "kill two birds with one stone."

The necessity of treatment for both classes of injuries, is at once apparent to all who have experienced the serious losses due to these agents. Obviously it is of little use to save a plum crop from the curculio, if it is to be destroyed by the fungous disease known as fruit rot; to save the raspberries from the slug if they are to be ruined by anthracnose; to save the grape buds from the flea-beetle if the berries are to be destroyed by black rot; or to save a pear crop from the ravages of the codling moth and curculio if it is to be distorted and disfigured by the scab. Or to take an example which will strike home to a large proportion of American farmers, it is scarcely worth while to save the potatoes from the Colorado beetle if they are to be ruined by a more serious enemy—the potato blight. While the necessity for preventing so far as possible the injuries of both these classes of organisms is obvious, it is almost equally evident that there will be a great loss of time and labor if each is treated separately. For instance the farmer who sprays his potatoes with the arsenites two or three times for the beetles, and then goes over them again with solutions of copper sulphate for the blight, would have accomplished the same end in half the time by mixing the copper sulphate and London purple or Paris green, in one solution, and applying them together. The same is true of the treatment of apples, pears, plums, and in fact of a large proportion of the crops liable to injury by both insects and fungi.

It seems to me that right here is a rich and virgin field reserved especially for cultivation by those station workers in whom are combined the functions of entomologist and botanist; and that it is a field which will well repay careful and exhaustive culture. It lies between the borders of the entomologist on the one hand and the botanist on the other, and requires that he who cultivates it to best advantage shall be thoroughly conversant with the most advanced methods employed by both.

At the Ohio agricultural experiment station, the present season, I have carried on a number of experiments with this end in view, and on the whole have obtained very satisfactory results. Among the substances tested, mention may be made of copper sulphate and London purple for blight and beetles affecting potatoes ; soda hyposulfite and London purple, and potassium sulfide and London purple for apple scab and codling moth ; copper sulfate and London purple for plum-fruit rot and curculio, and several other similar experiments, the results of which will be duly reported in the bulletin of our station.

The purpose of the present note is merely to call attention to this important work, which I hope will be borne in mind by my co-workers in the lines of botany and entomology in planning for future operations. C. M. WEED.

Ohio agr. exp. station, Sept. 2, 1889.

## STUDY OF NUTRITIVE RATIOS.

During the past winter, I had opportunity to renew trials begun 12 years ago touching the nutritive ratio laid down by Wolff. These trials have been virtually continuous with hogs, but were interrupted for steers for some three years.

I wish to express the belief that amounts to a conviction with me, that the function of the nutrients are less specific than supposed by German thinkers, or in other words that their offices are much more readily interchangeable. Instead of the necessity of maintaining a fixed and rigid nutritive ratio, in order to make the most economical use of food nutrients, I find, or think I find, that a radical variation of nutritive ratio may be made without affecting the amount of growth. Such a variation however has a most marked influence on the quality of the growth. If my observations are correct, then the true study of nutritive ratios will be to ascertain their relation to the development of the parts of the animal, as a variation of nutritive ratio at once varies the relation of the weight of the vital organs, composition of blood and ratio of fat to lean, as well as making other variations. After finding the minimum of protein that may be used, as well as its maximum, and maintain a standard growth, which may be 100 per cent. apart or more, and not change the rate of growth on swine, and I believe on cattle also, then we are to study its relation to the character of growth.

This I believe to be the true field of study of nutritive ratios, and that the present view is erroneously founded, and no longer calculated to advance the science of animal nutrition, and I would suggest that our investigators turn their attention more in this direction.

If the view expressed is correct, then we can determine very much the character of meat that we will produce, which character may vary in several radical particulars.

J. W. SANBORN.

Columbia, Mo., Sept. 3, 1889.

## THE MISSOURI AGRICULTURAL COLLEGE vs. PROF. J. W. SANBORN.

You were good enough to mention my charges touching the management of the Missouri agricultural college. Since the matter is thus before your readers, permit me to condense a volume into a few words. I have waged for the past two years a contest against the use of positions under me, as spoils, for mere politicians, against nepotism in its worst form, against violent misappropriation of funds, and a general anti-agricultural college atmosphere surrounding the department for which I was in a measure responsible. AGRICULTURAL SCIENCE reaches the agricultural college workers of this country. I wish them to know that my deposition grew wholly out of a contest made not only in the interest of our Missouri farmers but in the interest of departments of agriculture associated with universities, and hence is a matter of general interest. The contest is sustained by our farmers, and already largely successful, is promising to be wholly so in the end. Pardon this personal statement, but the issue here is a public and not a personal one and more sharply drawn than has before occurred in the history of agricultural colleges of this country.

J. W. SANBORN.

Columbia, Missouri, Sept. 3, 1889.

## RECENT LITERATURE.

ANNUAL REPORT OF THE MAINE STATE COLLEGE AGRICULTURAL EXPERIMENT STATION. 1888, pp. 223, fig. 34. Augusta: 1889.

Systematic, honest work at an experiment station is a necessity, if success is to be attained, and to a large degree the annual reports will tell us whether this is the case or not at the institutions from which they emanate. A careful perusal of this volume would indicate that the management is both systematic and honest. The organization and work of the station is clearly given, and the special fields of investigation of the several officers clearly outlined, covering the following points of study: (1) cattle foods, cattle feeding and animal products, by the director, W. H. Jordan; (2) fertilizer and crop production, by Prof. Balentine; (3) varieties of farm crops, agricultural botany and entomology, by Prof. Harvey; (4) animal diseases by Dr. Russell; (5) horticulture; (6) agricultural meteorology and physics, by President Fernald; (7) fertilizer inspection and (8) chemical analyses, by Messrs. Bartlett and Merrill.

This report contains but a comparatively small amount of experimental matter, for the reason that its publication was necessary before the completion of much work. Yet there are but few indications of unnecessary expansion in this book. A serviceable list of experiments and investigations conducted at the state college, the results of which are already published, is given. From page 27 to 63 occurs the fertilizer work, embracing analyses and tables—a class of data widely published by the stations. Prof. Balentine reports upon box and field experiments with fertilizers. In the box tests on oats, comparing various phosphatic manures with muriate of potash and ammonium sulfate. Carribean sea guano gave a 59 per cent. increase, aruba 54 and South Carolina rock 52 per cent. increase. In the field tests of fertilizers on oats and grass, stable manure gave the best results in one series, while in another series a complete fertilizer gave the best yield. Fourteen field fertilizer experiments were attempted by farmers, of whom eight were successful.

Interesting digestion experiments on sheep and pigs occupy some little space, as does a report on the compounding of rations for the different classes of farm animals. In the pig feeding tests, the results of two years' experiments favor feeding whole corn as the most profitable food for fattening.

Varieties of potatoes, peas, oats and barley were tested and reported upon. Germination experiments were conducted on seed from various sources, and we note that "the complaint about commission garden seeds is hardly sustained by our experiments." This is in accordance with the data of Prof. Bailey and others.

The entomologist describes, gives the life history and recommends remedies for over a score of farm insects.

To a considerable extent, the accompanying *errata* excuses the several errors in text. The general tone of the report is substantial and creditable, and the fact is patent that an effort is being made to accomplish results. It is easy to place this volume in the front rank of station reports, along with those of Mass., Conn., New Jersey, New York, Wisconsin, Pennsylvania, etc., for it is almost needless to say that these institutions represent the highest type of American experiment stations, no matter what their weaknesses may be.

FIRST ANNUAL REPORT OF THE SOUTH CAROLINA EXPERIMENT STATIONS, for the year ending Dec. 31, 1888, pp. 298. Columbia, S. C.: 1889.

Considerable of the material in this report has been incorporated in the previous bulletins of this station, which we have referred to from time to time. Some of this matter embraces original research, and is of interest, while other portions are of compilation

The most noteworthy and commendable part of the volume covers pages 162 to 291, and relates to investigations upon corn and cotton, bearing upon fertilizers, varieties, methods of planting, etc. Numerous tables occur, and as no summary of results is given, the report is thus made much less serviceable for the general reader, than it would have been had brief summaries been given, as is so commonly the case with progressive station reports.

The report of the chemist refers principally to feeding stuffs and standards, with analyses, and also analyses of a few fertilizing substances. Much of this matter is compilation.

The analyst of seeds renders a report on seed germinations, which indicates much work done.

We notice no reports from the vice-director, bacteriologist, and veterinarian, the director receiving the credit for most of the work done.

That there is much that is good in this book is unquestionably true. We do not wish to compare this with other reports, but if portions of it could have been materially condensed, if the strong points of the experimental work could have been more strikingly shown in print, and if as few technical terms had been used as was consistent with the character of the work, we believe the volume would have been much more serviceable in the state of South Carolina, where a large percentage of illiteracy exists among the people.

## PUBLICATIONS RECEIVED.

ALABAMA, Agricultural experiment station of the agricultural and mechanical college, Auburn. Bulletin No. 6, new series, July, 1889, pp. 40, plates XXIX. Grasses and their cultivation.

ALABAMA, Canebrake agricultural experiment station, Uniontown. Bulletin No. 5, July, 1889, pp. 14. Oats, wheat, meteorological report.

CORNELL UNIVERSITY college of agriculture. Bulletin of the agricultural experiment station. Agricultural department VIII. August, 1889, pp. 73–86. On the effect of different rations on fattening lambs.

FLORIDA, Bulletin No. 6 of the experiment station of, at the state agricultural college, Lake City, Fla. July, 1889, pp. 20.

INDIANA, Bulletin of the agricultural experiment station of. Purdue university, No. 27, August, 1889, pp. 12. Field experiments with wheat.

JAPAN, Imperial college of agriculture and dendrology, Tokyo. Bulletin No. 5, pp. 33. Researches on the distribution of vegetable and animal nutrients over the products obtained from rice by whitening; and on the manufacture, composition and properties of "Koji." July, 1889.

KANSAS, state agricultural college, Experiment station. Manhattan, Kan. Bulletin No. 7, July, 1889, pp. 75–87. Experiments with wheat.

KEW, ROYAL GARDENS. Bulletin of miscellaneous information. No. 32, August, 1889, pp. 191–216, plate I. The fluted scale insect. (*Icerya Purchasii*, Maskell.)

MISSISSIPPI agricultural experiment station. Bulletin, No. 5, pp. 23. Fertilizers. Agricultural college, Miss., May 20, 1889. Bulletin No. 8, Aug. 30, 1889, pp. 9. Stock feeding.

NEW JERSEY agricultural college experiment station. Bulletin 57, July 31, 1889, pp. 8. Experiments with different breeds of dairy cows. No. 58, Aug. 5, 1889, pp. 11. Analyses of incomplete fertilizers.

OHIO agricultural experiment station, Bulletin of the. Vol. II, No. 4, July, 1889, pp. 99–114. Article VII. Experiments with small fruits in 1889. VIII. Effect of early and late picking upon keeping quality of apples.

PENNSYLVANIA state college agricultural experiment station. Bulletin No. 8, July, 1889, pp. 7. Systematic testing of new varieties. Germination tests.

SOUTH CAROLINA agricultural experiment stations. Bulletin No. 6. New series II. July. 1889, pp. 23–31, plates II. Hog cholera.

VERMONT state agricultural experiment station. Bulletin No. 15, June, 1889, pp. 20. Effect of fertilizers on the composition of corn. Analyses of hay. Bulletin No. 16, July, 1889, pp. 8. Testing milk at creameries.

# ABSTRACTS.

## RESEARCHES ON THE MANUFACTURE, COMPOSITION AND PROPERTIES OF "KOJI."

(By O. KELLNER, T. MORI, and M. NAGAOKA: *Bull. 5, Imp. college of agriculture,* Japan.)

*Koji* is steamed rice or barley upon which is developed the mycelium of special fungus, which plays an essential part in various manufacturing processes peculiar to Japan and China. It is used as a saccharifying substance in the preparation of rice wine (*sake*) and alcohol (*shochiu*) and seems likewise to be the chief active ingredient which brings about the slow fermentation as well in the manufacture of *miso*, a food adjunct very common in Japan, as in the preparation of *shoyu*, a peculiar sauce also largely consumed in Japan.

The authors prepared koji from rice and barley in the following way, which is generally adopted in the koji works: The hulled grains were trodden on in a tank containing water, the latter being frequently changed. The grain was then steeped under water in a tank for one night, and then steamed in a large tub provided with a false bottom covered with cloth and fixed upon an iron boiler in which water was heated to boiling. When the steam passing through the tub had gelatinized the starch and rendered the grains flexible, the material was spread out upon mats and allowed to cool, the workmen stirring the grains meantime. At 28° C. a small quantity of grain was mixed with spores of *Eurotium Oryzæ*, there being two grams of the latter to 100 liters of grain. This seeded grain was then uniformly distributed over the whole mass of steamed grain. The mats and contents were then carried into the front part of a sort of cellar. Then after 18–20 hours, the steamed grains were spread out at 8 A. M. (the second day of whole process) in thin layers upon wooden trays, and carried into the interior of the cellar. At 6 A. M. the next day the grains, which had become very warm in the meantime, were separated by hand and sprinkled with water to diminish the heat. This was again repeated at 2 P. M. On the morning of the fourth day the koji was ready and represented a grayish mass bound together by a white mycelium. In this stage the koji must be taken to a cold place, otherwise the formation of spores would set in and the whole mass would turn brown.

The heat generated during the growth of the fungus is very considerable.

In the dry matter of koji from both rice and barley there is a relative increase of all ingredients, except of carbohydrates, which appear to be destroyed to some extent. Noticeable quantities of maltose and glucose indicate that the ferment produced by the fungus commences to act at once on the moist, steamed grain.

The loss of material caused by the growth of the fungus amounts in the case of rice to 13.3 and in barley to 19.3 per cent. of the total dry substance applied. In loss of organic matter the albuminoids have a slight share, as in both kinds of grain about 12 per cent. of their original quantity was decomposed into simpler nitrogenous bodies, among which exists a small proportion of ammonia. The total quantity of nitrogen applied appears not to have undergone any perceptible loss. The crude fat shows, as in all fermenting or decaying materials, a remarkable increase. Some fibre, too, is newly formed by the fungus for its cellular membranes, and the slight increase of ash is caused by the application of well water with which the koji is sometimes sprinkled.

The destruction concerns chiefly the carbohydrates, of which disappear from 100 parts of rice, altogether 17.66 per cent., and of barley 24.06 per cent.

The authors carried on a number of experiments on the carbohydrates with the ferment of koji, from which results they found that "the ferment of koji has strong diastatic properties: it converts cane sugar with great ease into dextrose and lævulose, maltose into dextrose, and gelatinized starch into dextrin, maltose and dextrose, whereas it does not act on milk sugar or inulin.

In comparing the effects of the ferments of yeast and koji on the carbohydrates, they found that neither of them acted on inulin or milk sugar, but that they strongly inverted cane sugar, and also that the invertin of yeast did not affect gelatinized starch or maltose, while the ferment of koji hydrated both, converting starch into dextrins, maltose and dextrose, and maltose into dextrose. In order to discriminate between the two ferments and also give expression to their resemblance in respect to their identical action on cane sugar, the name "*invertose*" is given to the soluble ferment of koji.

## ON THE DISTRIBUTION OF ANIMAL AND VEGETABLE NUTRIENTS OVER THE PRODUCTS OBTAINED FROM RICE BY WHITENING (CLEANING).

(By O. KELLNER: *Bull. 5 Imp. college of agriculture*, Japan.)

Rice used as human food or in certain manufactures is whitened and the bran separated from the grain. The grain is rubbed together in a mortar, the testa and most of the germs being scraped off. The ground mass is separated by sieves and fan mills into whitened grain, broken grain and bran. One hundred parts of rice yields 87–95 parts of whitened rice.

Analyses of rice before and after whitening as well as in the boiled state, from two different localities, show that whitened rice is poorer in albuminoids, fat and ash, than the raw hulled grain. Analyses were also made of rice from the province of Mino, superior grain, and from Echiu, a mediun sort. An average of these two varieties, in cleaning, shows 89.68 per cent. whitened grain, 7.35 bran, 1.12 broken grain. The composition of the grain is materially altered by cleaning, becoming relatively poorer in all ingredients save carbohydrates, which show an increase of 4.5 per cent. in dry matter. The bran, on the other hand, chiefly consisting of the testa and embryo, the tissues of which are extremely rich in albuminoids and fat, contains of every ingredient, carbohydrates excepted, relatively far more than the original rice. The analyses show that the composition of the whitened grain is dependent to some extent on that of the original rice. The poorer the hulled grain is in albuminoid and fat, the less is also found in the whitened product.

Japanese rice appears to be very poor in mineral stubstances, containing on an average of 12 analyses made in the laboratory, only 1.15 per cent. pure ash, while in the whitened grain but 0.5 per cent. occurring. In the ash of hulled rice was found, on an average of five complete ash analyses, 22.7 per cent. potash and 51.5 per cent. phosphoric acid, and in rice beans 16.7 per cent. potash and 45.1 per cent. phosphoric acid, with 9.45 per cent. total ash in dry substance.

## CHANGE OF SUBSTANCE IN THE HORSE AT REST AND AT WORK.

(By N. ZUNTZ, C. LEHMANN and O. HAGEMANN: *Bied. Centralblatt*, xviii, pp. 293–96.)

Respiration experiments were made with horses at rest and in motion, the expiring gases being collected by means of a brass mask over the horse's mouth, and examined. In some cases tracheotomy was performed and the gasses obtained directly from the trachea. The apparatus used for making the horse do the desired amount of work was a specially constructed treadmill. This and the other apparatus used are fully described with sketches in the original paper (*Landw. Jahr.*, xviii, 1–156).

In some experiments the expired air contained more oxygen and less carbonic anhydride when the horse was working, than when at rest; in other cases the reverse was observed. During the period directly following work, the rate of respiration remained still much above the normal rate, but there was no increased, oxidation, the oxidation becoming normal the moment the work ceased. Hence the amount of oxygen in the expired air is high, and that of carbonic anhydride very small during this period. The oxygen deficit is, however, more diminished than the amount of carbonic anhydride; this is due to the fact that the lessened pressure of carbonic anhydride in the lungs gives rise to an increased evolution from the blood. In this way the whole body becomes poorer in carbonic anhydride.

Determinations of oxygen consumed and carbonic anhydride produced by horses at rest and working gave different results with different kinds of work; in nearly all cases in which two periods of work follow one another, the second period gave rise to a less consumption of oxygen, and less production of carbonic anhydride, so that the production of work takes place with greater economy after a period of activity.

There is no constant relation between the consumption of substance and amount of work; the whole organism of an animal, its individual and periodically different behavior, variety of feeding, etc., make great differences in the economical use of its strength, even in doing the same work.

*Ab.: Jour. chem. soc., 1889, pp. 911–12.*

## COMPOSITION OF MILK PRODUCED ON ENGLISH DAIRY FARMS.

(By P. VIETH: *Jour. roy. agr. soc.*, xxv, pp. 180–202.)

This paper contains the results of analyses of 84,746 samples of milk made from 1881–1888. The milk supplied to London comes from at least half the English counties, and is therefore fairly representative. The determinations were: Total solids, non-fatty solids (important as being the most constant factor), and fat, which is the most valuable constituent. The non-fatty solids contain, with little variation, six-twelfths parts of milk sugar, one-twelfth part ash and five-twelfths proteids, rather more than two-thirds of the latter being casein. The results are shown in curves, the most striking feature of which are the great uniformity of the non-fatty solids and the rather large variations in the percentages of fat which cause the total solids to fluctuate to about the same extent.

The best milk is obtained in November, when most cows give a limited amount; in the spring months there is an increased flow of milk of a poorer quality. The composition of morning and evening milk is also shown in diagrams: the evening milk is almost invariably the richer, and this difference is ascribed to the inequality of the intervals between the two milkings.

Notwithstanding the variations in the milk, the specific gravity of the mixed yield of several cows rarely falls outside the limit of 1.030 and 1.034, and this is explained by the fact that the higher percentage of fat, which tends to lower the specific gravity, is generally accompanied by an increased amount of non-fatty solids exercising an influence in the opposite direction. Even in the case of milk of individual cows there are comparatively few exceptions, and of these by far the greater number are not lower than 1.029, nor higher than 1.035. The lowest and highest figures observed were 1.0240 and 1.0365 respectively.

*Ab.: Jour. chem. soc., 1889, pp. 914–15.*

## COLORING MATTERS OF FUNGI.

(By W. ZOPF: *Bot. Zeit.*, 1889, pp. 53–61, 69–81, 85–92.)

The fungus *Polyporus hispidus*, contains a beautiful yellow, resinous substance which much resembles the gamboge of *Garcinia Morella* in many of its reactions, and the author names it therefore, fungus gamboge. Another, a yellow or greenish-yellow substance, occurs in the same fungus, and also has an acid character.

In the hymenium of the Telephoria, a coloring material, composed of at least three different substances, is found. It includes telephoric acid, a beautiful red dye, a yellow non-crystalline substance, and a yellow resin acid. The polyporus, *Trametes cinnabarina*, contains two beautiful yellow substances, the one forming cinnabar-colored crystals, the other being probably a resin. These substances all occur in the hymenium.

The author has found a lipochrome in *Bacterium agregium*, an orange-yellow, fatty substance. The alcoholic solution shows an absorption band at F, and a weaker one between F and G, in the spectrum, corresponding with those of the spectra of anthoxanthine and the fatty coloring material of the Uridineæ. The formation of the lipochrome occurs independently of the presence or absence of light.

*Ab.: Jour. chem. soc., 1889, p. 919.*

## ALCOHOLIC FERMENTATION OF MILK.

(By MARTINAND: *Comp. rend.*, cviii, pp. 1067–9.)

Under suitable conditions alcoholic fermentation of the sugar and coagulation of the milk take place with all kinds of yeast, including that described by Duclaux (*Ann. Institut Pasteur*, Dec., 1887). If a 10 per cent. solution of glucose or maltose is mixed with 10 to 80 per cent. of milk, and Duclaux's yeast or *Saccharomyces cerevisiæ*, *ellipsoideus*, *pastorianus*, or *apiculatus* is added, the milk coagulates in from 17 to 60 hours. The same result is obtained with saccharose, except with *S. apiculatus*, a result due to the absence of invertin in this species. Coagulation is not due to the formation of an acid, since a solution of the fermented sugar cannot coagulate milk after filtration through a Chamberland's filter.

With Duclaux's yeast, the time required for the coagulation of milk varies with the quantity of added water. Pure milk, or milk with less than 20 per cent. of added water, does not coagulate, but in other cases coagulation takes places after a time which is shorter the greater the proportion of water. With 80 and 90 per cent. of water, however, coagulation does not take place. The quantity of alcohol produced decreases as the proportion of water increases. If the diluted milk is mixed with 10 per cent. of fermentable sugar, coagulation takes place in all cases, the time required being longer the greater the proportion of water.

When milk is filtered through a Chamberland filter, it becomes turbid, before any appreciable quantity of alcohol is formed. With the same milk not filtered, coagulation is not sudden, but a precipitate of casein forms and increases until fermentation ceases. Precipitated casein, dissolved in a solution of sugar and filtered through Chamberland's filter shows the same phenomena when fermented. The fact that the action on soluble casein, suspended casein and precipitated casein is the same, is readily explained by assuming that in milk there is only one albuminoid.

*Ab.: Jour. chem. soc., 1889, p. 916.*

## NITRATES IN THE RAIN OF TROPICAL DISTRICTS.

(By A. MUNTZ and V. MARCANO: *Comp. rend.*, cviii, pp. 1062–4.)

Recent researches having shown that soils and plants have the power of absorbing nitrogen directly from the atmosphere, determinations of the nitrates in rainwater are mainly valuable as evidence of the magnitude of atmospheric electrical discharges in the particular district.

The rainwater was collected in the manner previously described (*Comp. rend.*, xcvii, p. 240) at Caracas, Venezuela, which is situated in latitude 10°3′ N., at a height of 922 metres above sea level. The temperature in this locality is very uniform, the mean being 21.8, rains are very irregular, and storms are frequent and violent. Sixty-three samples of rain were collected in 1883–4, and 58 in 1885. The results are expressed in milligrams of nitric acid per litre:

| | |
|---|---|
| July, 1883, to July, 1884 | 2.45 milligrams. |
| January, 1885, to December, 1885 | 2.01 " |

The mean is 2.23, the minimum being 0.2 and the maximum 16.25 on October 19, 1883. The mean result obtained by Boussingault at Liebfrauenberg, Alsace, was 0.18, and by Laws and Gilbert at Rothamsted, Eng., 0.42. It is obvious that the quantity of nitric nitrogen in rain water is much greater in tropical than in temperate regions, and the total weights of nitrogen which fall upon a given area show still greater differences because the depth of rain is so much greater in the tropics. Taking the annual rainfall at Caracas as one metre in depth, the weight of nitric nitrogen per hectare would be as follows:

| | |
|---|---|
| At Caracas | 5.782 kilos. |
| At Liebfrauenberg | 0.330 " |
| At Rothamsted | 0.830 " |

At St. Denis in the island of Reunion, latitude 20° 5′ S., 19 specimens of rain collected by Raimbault in 1886-7, gave a mean of 2.67 milligrams per litre, the maximum being 12.5, and the minimum 0.4. This corresponds with a weight of 6.93 kilos of nitrate nitrogen per hectare.

It is evident that the quantity of nitric nitrogen in the rain of tropical districts is so large as to be of considerable practical importance. It is equivalent to 50 kilos. of sodium nitrate per hectare.

*Ab.: Jour. chem. soc., 1889, pp. 923-4.*

## ON THE FORMATION OF AMMONIA IN ARABLE SOILS.

(By A. HERBERT: *Annales agronomiques*, xv, pp. 355-69.)

The experiments recorded were undertaken to determine the influence of ammonia salts upon vegetation. The following is a summary of the author's conclusions:

1. It is necessary to heat humid soil above 100° in order to produce a certain quantity of ammonia.
2. If we have added to the soil increased proportions of ammonia salts, this production of ammonia diminishes more and more, and stops when reaching a certain limit.
3. This production of ammonia follows the course of a phenomenon of dissociation.
4. This production of ammonia seems to depend upon the composition of the amides in the soil.

## UPON THE FORMATION OF STARCH IN CHLOROPHYLL GRAINS.

(By G. BELLUCCI: *Bied. Centr.*, xviii, 209.)

These experiments were made upon the branches of the grape. The leaves would not produce starch in a moist atmosphere of nitrogen or hydrogen, but it was developed in very small quantities in oxygen and in carbonic acid. In the case of oxygen, the starch corresponded without doubt to the carbonic acid, which would have been produced by respiration. Leaves very rich in nitrogen were not visibly impoverished during the night in an atmosphere of carbonic acid, hydrogen or nitrogen, but the starch totally disappeared during the night in the atmospheric air, and more rapidly even in pure oxygen.

In determining the starch and glucose, the author found the glucose to increase more than the starch during the day, and that this increase was very considerable in an artificial atmosphere of carbonic acid and oxygen. The quantity of glucose increases more rapidly than that of the starch. During the night the starch disappears, sometimes entirely so, while the quantity of glucose remains the same; but he also shows that for glucose that may disappear is a compensation in starch formed.

Operating upon cut branches, different results are obtained:

the glucose increases in proportion as the starch decreases, and this increase is less than the loss in starch.

It is shown from these experiments, that the study of starch formation in chlorophyll grains cannot be made upon the complete plant. This is unfortunate, as all evidently depends on the direction which we are able to give to these researches. It is clear that the glucose coming from the autochthonous starch is not able to pass from a cut leaf. This is not so much the relation of assimilation and change of immediate principles as that of migration of these principles, by which the cut leaves are distinguished from those which remain in communication with the entire plant.

*Ab.: Annales agronomiques, xv, pp. 382–3.*

## EXPERIMENT STATION ABSTRACTS.

### ANIMAL NUTRITION.

### ON THE EFFECT OF DIFFERENT RATIONS ON FATTENING LAMBS.

(*Cornell university agricultural experiment station. Bull. vii, pp. 73–86.*)

The feeding period lasted from Nov. 25, 1888, to April 25, 1889. Twelve coarse wool grade Shropshire or southdown lambs, dropped late the previous spring, that were scantily summer fed, were used. They were closely shorn and divided into four lots of three each. However, owing to accidents the computations are based upon the two heaviest animals in each lot.

Lot III was fed all the timothy hay and whole corn they would eat, plus half a pound of turnips or mangels daily. Lot IV was fed two parts wheat bran and one of cotton-seed meal. One pound per day was first fed, and later increased or diminished as required. Clover hay instead of timothy, and the same roots as lot III were fed. Lot V was fed an intermediate ration, consisting of three parts corn and one each of wheat bran and cotton-seed meal, plus timothy hay and roots. Lot VI was fed like V, except that they received no roots at all.

The following table gives the gain in pounds and also in per cent. of weight.

| | | Wt. Nov. 25. | Wt. April 25. | Gain. | Gain. |
|---|---|---|---|---|---|
| III. | No. 11 | 59 | 78.88 | 19.88 lbs. | 33.7 p. ct. |
| | " 21 | 36 | 64.88 | 28.88 " | 80.2 " |
| | Average | 47.5 | 71.88 | 24.38 " | 51.3 " |
| IV. | No. 13 | 45.5 | 85.13 | 36.93 " | 87.1 " |
| | " 16 | 50.5 | 88.19 | 37.69 " | 74.6 " |
| | Average | 48 | 86.66 | 38.66 " | 80.5 " |
| V. | No. 14 | 53 | 96.44 | 43.44 " | 82. " |
| | " 20 | 50 | 81.69 | 31.69 " | 63.4 " |
| | Average | 51.5 | 89.06 | 37.56 " | 73. " |
| VI. | No. 15 | 58 | 91.88 | 33.88 " | 58.4 " |
| | " 19 | 51.5 | 75.31 | 23.81 " | 46.2 " |
| | Average | 54.75 | 83.59 | 28.84 " | 52.7 " |

The following figures, which illustrate the gain in weight in relation to the amount and cost of food consumed, are quite striking:

| LOT | III. | IV. | V. | VI. |
|---|---|---|---|---|
| Digestible carbonaceous food eaten, lbs... | 296.20 | 288.08 | 328.56 | 299.75 |
| " nitrogenous " " "... | 29. | 75.88 | 54.71 | 51.73 |
| Total digestible nutrients consumed, "... | 525.20 | 363 96 | 383.27 | 351.48 |
| Nutritive ratio........................................ | 1:10.9 | 1:4.2 | 1:6.5 | 1:6.3 |
| Total gain in weight (both lambs) lbs...... | 48.75 | 77.31 | 75.13 | 57.69 |
| Pounds nutrients eaten for 1 lb. gain...... | 6.67 | 4.71 | 5.10 | 6.09 |
| Total cost food eaten................................ | $3.70 | $4.66 | $4.78 | $4.51 |
| Cost of gain per 100 pounds...................... | 7.59 | 6.03 | 6.36 | 7.82 |

The effect on the wool production was that nitrogenous food largely affected its growth.

The effect of these foods upon the carcasses was as follows: Pronounced leanness of lot IV, the kidneys not being covered, and very little fat next the skin, the reverse of the other lots. Lot III carcasses had the most tallow between skin and body, and showed the largest percentage of waste fatty matter about the root of tail and in flanks. In a previous experiment the dressed weight of the nitrogenous fed lambs was nine per cent. greater than the carbonaceous fed; this year the results were about reversed.

## VEGETABLE PHYSIOLOGY.

### EFFECT OF EARLY AND LATE PICKING UPON THE KEEPING QUALITY OF APPLES.

(*Ohio agricultural experiment station : Bull. No. 4, pp. 111–14.*)

One hundred perfect apples of each variety were selected at each picking, and stored in crates in an ordinary cellar. Shrinkage mostly occurred before the expiration of two months. Lot A was picked Sept. 26, B, Oct. 6, C, Oct. 13 and D, the 20th. The following table gives most of the data, from which it can be seen that no difference in keeping qualities between early and late pickings was manifest after two months, though before six months passed, Baldwin, Roxbury russet and Jonathan favored early picking, while Newtown pippin and Ben Davis showed a difference in favor of early picking before the expiration of six months from date of picking:

| Lot | | Number sound after being picked. | | | Total shrinkage in rot and weight 58 days from picking. |
|---|---|---|---|---|---|
| | | 58 days. | 175 days. | 256 days. | |
| Baldwin | A | 79 | 67 | 3 | 32 per cent. |
| | B | 74 | 46 | 0 | 31 " |
| | C | 68 | 35 | 0 | 35 " |
| | D | 77 | 36 | 0 | 26 " |
| Roxbury russet | A | 96 | 83 | 5 | 20 " |
| | B | 77 | 64 | 1 | 34 " |
| | C | 86 | 56 | 1 | 23 " |
| | D | 72 | 22 | 1 | 35 " |
| Newtown pippin | A | 76 | 52 | 13 | 43 " |
| | B | 54 | 45 | 8 | 52 " |
| | C | 71 | 60 | 7 | 33 " |
| | D | 66 | 49 | 1 | 34 " |
| Jonathan | A | 86 | 53 | 11 | 33 " |
| | B | 76 | 46 | 8 | 28 " |
| | C | 67 | 28 | 2 | 41 " |
| | D | 83 | 33 | 0 | 31 " |
| Ben Davis | A | 99 | 93 | 44 | 13 " |
| | B | 97 | 90 | 33 | 10 " |
| | C | 95 | 85 | 12 | 13 " |
| | D | 97 | 89 | 12 | 8 " |

## PLAT TESTS.

### EFFECT OF FERTILIZERS ON THE COMPOSITION OF CORN.

(*Vermont agricultural experiment station: Bull. No. 15, pp. 16.*)

This experiment embraced a test of fertilizers on 16 plats. In order to control the conditions to a certain extent, the earth was dug out of a trench six feet wide and 96 feet long, to the depth of 18 inches. The trench was then divided by board partitions into 16 plats, each six feet square and 18 inches deep. When these were filled with dirt, each load was scattered as evenly as possible over the whole 16 plats. The soil used was a clay-loam from the surface of a recently plowed sod ground, and a load of clear sand was added to each two loads of the loam. When the ground had settled, it was levelled, the fertilizer intended for each plat scattered broadcast over it, and then each plat spaded six inches deep and the fertilizer and soil thoroughly mixed. The two end plats and one near the middle were left without fertilizer.

The crops from plats one, nine and 16 that had no fertilizer weighed 17½, 16 and 17 lbs. respectively and plaster land gave the smallest yield, and insoluble phosphoric acid from slag the largest, or 26 lbs., nitrogen, phosphoric acid and potash coming next. The highest yields were obtained from those plats that received phosphoric acid either alone or with other materials.

In dry matter, plat one yielded more than the other two not fertilized. Nitrogen alone and nitrogen with potash produced about the same amount of dry matter as did the unfertilized plats, and potash and land plaster appeared detrimental. Only with phosphoric acid applications was there an increase in dry matter to a noticeable extent.

The highest per cent. of fat occurred in the plat that received phosphoric acid from slag and those that had no fertilizer.

## ANIMAL PHYSIOLOGY.

### HOG CHOLERA.

(*South Carolina agricultural experiment station: Bull. No. 6, pp. 23-31.*)

The symptoms of disease are as follows: diarrhœa, loss of appetite, emaciation, weakness of hind quarters, followed by drowsiness, often severe cough, skin of belly inside of thighs and under throat more or less red, tenderness over abdomen. In acute cases death may occur in a few hours or days. Internally about the ileo-coecal valve are found large and small ulcers, extending to the guts; occasionally, instead of ulceration the mucous membrane is red and thick. The ulcers are round or oval projecting above the surrounding membrane, and in color may be yellow or black. Large areas of the lungs may be dark purple, noticeable when the animal has a cough. The spleen is often much enlarged in acute cases and covered with minute red dots, the liver and kidneys frequently exhibiting a similar appearance, the former being much harder than usual. The inguinal lymphatic glands are much enlarged and can be felt as hard as knots in the groin. The lymphatics of the mesentary or membrane holding the intestines in place, are much enlarged and appear as dark red lumps the size of a pea and upwards.

Several germs were found in the diseased parts, only one of which it is thought is concerned with the disease. This is of a deep green color when grown in beef tea, etc., and inoculated under the skin of a mouse invariably kills it in a few days. One out of two rabbits inoculated died some days after the mice did. Inoculations of five c. c. liquid cultures on hogs enlarged the lymphatic glands on the thigh where incision was made. Hogs fed 250 c. c. suffered only slight loss of appetite.

The organism is a medium sized bacillus, with rounded ends, 1.4 to 2.8 micro-millimeters in length, and 0.9 in thickness.

The authors condemn the use of drugs in treating diseased animals, offer no remedy, but suggest preventive measures such as are common sanitary conditions during infectious disease.

## AGRICULTURAL SCIENCE NEWS.

Washburn and Tollens have succeeded in isolating crystalline cane sugar from ripe maize (*Ber.* xxii). Sugar corn gave the highest amount of sugar.

Mr. T. H. Middleton has been appointed professor of agriculture to Baroda college, India. He is a graduate in agricultural science at Edinburg university, Scotland.

Mr. L. O. Howard has an illustrated article in *Insect life* (II, pp. 34-41) upon a newly imported elm insect, *Gossyparia ulmi*, Geof., described by Signoret in *Annales de la Société Entomologique de France* for 1875.

Eugene Davenport has been elected to the chair in agriculture at the Michigan agricultural college. He graduated at that institution in 1877, and for the past year has been the assistant of Prof. Beal.

The large barn on the experimental grounds of the university of Illinois, near Champaign, was burned early in September, with all the farm machinery, hay and grain. Loss about $5,000 and no insurance.

Dr. C. V. Riley, entomologist to the United States department of agriculture, has been created chevalier of the legion of honor by the French government. He has also been elected an honorary fellow of the entomological society of London.

At the Toronto meeting of the American association for the advancement of science was formed the association of official economic entomologists. The following are the officers: Pres., C. V. Riley; first vice-president, S. A. Forbes; second vice president, A. J. Cook; secretary, J. B. Smith.

Mr. D. W. Coquillett writes *Insect life* (II, p. 49) that he has found the Icerya, for the first time feeding upon a conifer—the cedar of Lebanon (*Cedrus lebani*). He also records a new enemy of this insect, *Telephorus consors*, Le Conte, having been discovered feeding upon the eggs of the Icerya.

The special course in agricultural science for rural teachers was opened at Edinburg university, Scotland, on Sept. 2. Two lectures are delivered every morning on agricultural science by Prof. McConnell of Oxford university, and one on chemistry every aftermoon by Mr. Falconer King. Saturdays are devoted to excursions to prominent farms.

The August bulletin of miscellaneous information from the royal gardens at Kew, is upon the fluted scale insect (*Icerya Purchasii*). The text is quite comprehensive, and a beautiful colored plate illustrates the insect in its various stages. The bulletin is a compilation from various authors, but mainly the report of C. V. Riley in the U. S. department of agriculture report for 1886.

Mr. L. N. Bonham in a note to *Insect life* (II, p. 47) describes how he watched a large flock of blackbirds in a 24 acre corn field, and that the birds did not eat the corn, but rather destroyed thousands of boll worms. Of this fact he is positive, as he watched many individual birds on ears of corn, saw them make passes as though picking out the worms, and after their flight he could find no worms and the grain was uninjured.

Dr. Geo. H. Cook, director of the New Jersey agricultural experiment station from its organization, and for years professor of agriculture in Rutgers college, died on Sept. 22 of heart failure. Dr. Cook was born Jan. 5, 1818, at Hanover, New Jersey. He graduated from Rensselaer polytechnic institute in 1839. After filling several positions, in 1853 he accepted the chair of chemistry and natural history at Rutgers college, New Brunswick, N. J. From 1854-56 he was an assistant on the New Jersey geological survey, and upon its reorganization in 1864 was appointed state geologist, which position he held at his death. Dr. Cook's influence upon agriculture and science was of the healthiest character, and his death removes from the field of agricultural experiment station work in America one of its most helpful advisers and workers.

At a meeting of the Linnean society of New South Wales on June 26, (*Nature*, 1034) Dr. Oscar Katz read a paper concerning his experimental researches with microbes of chicken cholera, and describes his investigations as undertaken since 1888. The larger portion of the experiments were made on wild rabbits, although the action of the microbes on domestic poultry, as well as indigenous birds, hares, guinea pigs and ferrets was studied. A number of other points in the life history of the chicken-cholera bacteria were dealt with; for example, their behavior when transmitted through the bodies of rabbits in successive generations; towards desiccation, putrefaction, etc. Rabbits were repeatedly protected against a virulent infection, from having previously partaken, at intervals, of cultures of the microbes in which the latter had been killed by moderate heat.

In the *Gardeners' chronicle* of Sept. 7, Mr. W. H. Divers of Stamford, England, relates his experience in applying ferrous sulfate for chlorosis or peach "yellows." He says: "Owing to the drainage being badly laid when one of our peach houses was built, I found it necessary to lift a number of large, old trees in November, 1887, and put in fresh drainage. One of these trees was princess of Wales peach, and which was severely checked and weakened by being lifted, and early this spring it was badly affected with chlorosis or "yellows." I accordingly removed the soil about one foot in depth, immediately over its roots, and dissolved .75 lb. sulfate of iron in water, at rate of .75 oz. to five pints warm water. This was poured over the roots and washed in with a plentiful supply of clean water, while the soil was moist; the surface soil was then returned, as before. In about a fortnight the tree had improved considerably, and is now quite healthy."

Mr. W. Mattieu Williams, in *Nature* (Aug. 22, '89,) gives an explanation for the discrepancy which exists between the results obtained in nitrogen experiments on plants grown in free air instead of closed vessels. This explanation is suggested through observations of his own on atmospheric dust particles. Sheets of paper, smeared with adhesive coatings, and shallow vessels of water, were laid on the ground in a garden near Willesden. The resulting catch included far more organic than inorganic matter, the former consisting chiefly of small insects. The amount of these was surprisingly great towards the end of summer or beginning of autumn, quite sufficient, he thinks, to account for the varying results obtained by Sir J. B. Lawes and Prof. J. H. Gilbert, especially for the "eccentric" behavior of the Leguminoseæ —"sometimes the plants died of nitrogen hunger; sometimes, after a time of such hunger, they recovered and produced abundant growth." The author thinks the explanation may be confirmed or refuted by exposing an unplanted layer of sterilized sand, or other soil, of the same area as that on which the experimental plants are growing, and comparing the gain of combined nitrogen in both cases.

## EXPERIMENT STATION ITEMS.

Mr. Lucius P. Brown, graduate of the university of Virginia, has been appointed acting chemist to the Tennessee station.

Prof. E. M. Shelton will remain at the Kansas agricultural college till Jan. 1, thus closing up his year's work, before going to Queensland.

Dr. W. E. Stone, chemist of the Tennessee station, has resigned his position at Knoxville to accept the professorship of organic chemistry at Purdue university, LaFayette, Indiana.

Bulletin eight of the Pennsylvania station gives a list of the small fruits growing at the station, viz.: strawberries, raspberries, blackberries, currants and gooseberries. Germination tests of alfalfa, barley, clover, corn, cane, oats, etc., are given.

Owing to ill health, Mr. S. S. Twombly, has been compelled to sever his connection with the Arkansas station, as chemist and vice-director. Mr. Twombly will study in the veterinary department of McGill university, Canada, the coming session.

Bulletin six of the Alabama station is upon grasses and their cultivation. Twenty-nine species are illustrated in full page plates, and general descriptive and useful notes fill most of the pages. A list of the grasses found growing in Alabama is also given.

Bulletin No. 6 of the Florida station consists mostly of analyses of potable waters, both artesian and well, gypsum, ashes, phosphate, humus and muck, bat guano and soil. The botanist reports upon *Trifolium incarnatum* and suggests its use as a forage plant. *Poa arachnifera* is also under trial. Plans of the chemical laboratory and station headquarters are given.

Bulletin 57 of the New Jersey agricultural college station gives in tabular form data concerning experiments with three Ayrshire, three Guernsey, two Holstein-Friesian, three Jersey and three short horn cows. It gives a list of the cows with breeding data, with milk and feeding records for May, June and July. Bulletin 58 of this same station gives analyses of incomplete fertilizers.

As an average of 66 analyses of timothy hay from various parts of the state, the Vermont station found 12.60 per cent. water, 4.06 ash, 6.16 albuminoids, 29.49 fibre, 45.34 nitrogen-free extract and 2.35 per cent. fat in the original substance. In the water-free were found 4.65 per cent. ash, 7.05 albuminoids, 33.74 fibre, 51.87 nitrogen-free extract and 2.69 per cent. fat.

Bulletin five of the Mississippi station gives "some facts in regard to the most economical use of fertilizers, both natural and artificial." The station has on record 110 analyses of soils from different parts of the state, from which it is estimated that there exists in the first six inches of soil on an acre, 6,060 lbs. potash, 2,190 lbs. phosphoric acid and 3,680 lbs. nitrogen. It is an instructive fertilizer bulletin.

Bulletin five of the Alabama cane brake station reports upon experiments with oats, upon drained and undrained land, with different fertilizers, and gives the effects of methods of preparation. Wheat varieties were tested, and wheat was experimented upon on drained and undrained land. Further, a meteorological report shows the relation between rainfall and drainage, and the subject of water supply for cattle is discussed. In growing the oats, the best results occurred upon the drained land.

"Experiments with wheat," is the title of bulletin seven of the Kansas station. Prof. Shelton writes in a clear, practical manner on the argument for wheat raising; pasturing wheat, growth of varieties and the best sorts; fertilizers on wheat; salt as a fertilizer on wheat and oats; listing wheat. The most interesting experimental data records the effects of fertilizer on wheat compared with no application. The fact is strikingly brought out, in 45 comparative plats, that in the great majority of cases the largest crops of grain results from non-application of manure.

"Field experiments with wheat," by Prof. W. C. Latta is the subject of bulletin 27 of the Indiana station. In comparing varieties, Velvet chaff gives the best general results, with Michigan amber second. The experience of the station is that the evidence steadily accumulates in favor of thick seeding, this for five years' of trial, but for quantities over six pecks, the increase is slight. From the first, in four successive yearly trials, the use of the drill gave better returns than broadcasting. One season's comparison of large vs. small seeds, shows no material difference. The rotation of grain and grass crops shows better results than grain crops being grown continuously.

Bulletin 16 of the Vermont station is upon testing milk at creameries. The station tested from 11 creameries, and found that on the average they lost 10 lbs. of fat out of each 100 lbs.; that they then mixed 18 pounds of water and salt with the remaining 90 lbs., so as to bring up the final butter product to 108 lbs. The average butter composition was · butter fat 83.1 per cent., water 12.00, salt 4.4 and curd 0.50 per cent. In referring to Short's method the statement is made that dairy firms are selling tubes that are faulty, thus injuring the efficacy of Short's method. The bulletin illustrates a method of paying for the milk at creameries, and offers instructions for using a table for this purpose.

Bulletin eight of the Mississippi station is entitled "stock feeding," though five of the nine pages are upon making ensilage and silos. Eight tons of green *Sorghum vulgare* were piled in a heap, uncut, and covered with earth a foot thick. The stack was fairly well preserved, and the cattle ate the food readily. A bill of materials necessary for constructing three station silos, is given. Four mules were tested in a feeding experiment, but the results seem to us to signify nothing. Twenty-one calves were fed different feeding stuffs in a trial of foods. Grade Jerseys increased faster than grade Holsteins. Blatchford's food when used alone did not give good results, while mixed with other foods it did. Whole milk was fed at a loss. It was concluded that cotton feed in some form is the cheapest of the foods tried.

Bulletin four of the Ohio station contains an excellent report upon small fruit experiments at the station in 1889. Tabular data are given concerning varieties, covering the following points: date of first picking; weight of 25 average berries; weight of five selected berries; average diameter of selected berries; number in one quart of average berries. Of strawberries, Bubach, Haverland, Ohio, Pearl, Crescent and Warfield are recommended for general planting. Eureka, Crawford, Enhance, Miami and Viola are promising. Jessie, Lida, Louise, Logan, Jersey Queen, Sharpless and Cumberland are suited to private growers and amateurs. Belmont, Bomba, Monmouth, Mammoth. Pineapple and Carmichael will probably soon be discarded. Of raspberries, Hilborn, Muskingum and Palmer are recommended for general culture. Rancocas, Marlboro and Springfield will probably be discarded, or cultivated in but few localities. Among the blackberries Agawam, Ancient Briton, Bonanza, Early harvest, Taylor and Snyder are best and most worthy of cultivation in the vicinity of Ohio. Erie, Minnewaski, Early king, Lawton and Kittatinny are valuable for less severe climates. Brunton's early, Crystal white, Dehring, Early cluster and Wilson, Jr., are not worthy further trial.

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# THE SOILING SYSTEM FOR MILCH COWS.

BY H. P. ARMSBY, WM. FREAR, H. J. PATTERSON, GEO. L. HOLTER AND W. H. CALDWELL.

As the value of land increases. and the cost of interior fences becomes felt as a growing burden, there is a natural incentive toward producing milk and butter from as small an area as possible, and, as a result, the question of the economy of the soiling system becomes of increasing interest. By this system a much larger amount of fodder can be grown per acre than is produced by average pastures, and the adoption of the system will turn largely on the question whether the gain in this direction under any given circumstances is sufficient to more than cover the extra labor involved in cutting the crop and carrying it to the animals. Other considerations are, of course, involved; as, for example, the fact that in pasturing stock there is considerable loss through the trampling of the grass by the animals and in other ways. Further, the fact of the irregularity in the yield of pasture at different seasons, as illustrated in one of the experiments described below, is an important element in the case. Naturally, too, the soil and climatic conditions of a locality, as affecting the certainty and regularity with which pasturage or soiling crops may be produced, are weighty factors in the question.

Although when animals are fed exclusively on green fodder the expense of cutting and carrying the fodder to them is very considerable, yet when dairying is the main business, pastures are rather unsatisfactory as a sole reliance throughout the summer season. Many advanced dairymen have sought to combine the advantages of pasturage and soiling by a system of partial soiling, depending wholly or mainly upon the pastures early in the season and supplementing them with clover or corn later when the growth of the grass falls off, and in some cases with grain also. The system of feeding which has been practiced upon this farm for several years is another form of partial soiling. We have no pastures, the cattle being fed entirely in the barn. During the summer season they receive about half their fodder in the form of hay and grain and the remainder in the form of the various soiling crops. They are fed in the barn night and morning, and during the day are allowed to run in a small piece of woodland where they have the benefit of the shade and coolness, but where they get no appreciable amount of fodder. Quite extensive investigations of the yield and composition of soiling crops have already been carried on here by Dr. Frear previous to the establishment of the station. The investigations reported below, while supplying additional data on this point, have a more extended scope. They include:

1. An investigation of the yield and composition of pasture grass.
2. A determination of the digestibility and nutritive value of young grass, including also a comparison of the digestibility and nutritive effect of green grass with those of the same grass dried.
3. Digestibility of soiling crops.*
4. Observations on the yield per acre of soiling crops, the composition of rations actually eaten by the cows, the yield and composition of milk, and the area of soiling crops required per cow and per 100 lbs. of milk produced.

Exact knowledge on these fundamental points is necessary before a satisfactory estimate can be made of the relative cost and profit of pasturing and soiling. These experiments are an attempt to add to our present meagre knowledge on this point. They are, however, only a beginning in this direction. All these factors necessarily vary with locality and with the season, and a single year's work cannot settle any of them definitely. Moreover, in these experiments we simply took the system which has been in use here for a number of years as the basis of investigation. The rations fed are not proposed as models. In fact it is not improbable that they could be improved. The cows used, moreover, were far from being the best, and this results in making the cost of production considerably higher than it should be, although this does not necessarily affect the value of the comparisons drawn between soiling and pasturage. In short, this present report is a report of progress. It is our hope to be able to continue and extend these investigations in future years until sufficient data are accumulated for some definite conclusions.

The methods of analysis used throughout the experiments were those of the Association of official agricultural chemists. In the statements of results "albuminoids" signifies albuminoid nitrogen by Stutzer's method×6.25. "Non-albuminoids" signifies non-albuminoid nitrogen×6.25. In the experiment on the yield and composition of pasture grass, all weighings were made on a laboratory balance sensitive to 0.5 grm. In the experiment on green vs. dried grass, the weighings of fodder, dung, and milk were made on a Fairbanks' silk scales, sensitive to ¼ oz. In the experiment on the nutritive value of soiling crops, the weighings of hay and of soiling crops were made on a Fairbanks' platform scales reading to 2½ lbs. ; those of grain on a portable platform scales reading to ¼ lb. ; those of milk on the silk scales above mentioned, reading to ¼ oz. In both the latter experiments the weights of fresh and air-dry samples in the laboratory were taken on a balance sensitive to 0.5 grm. Weight of animals and of water drunk were taken in the large platform scales mentioned above.

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*To be reported on in detail later.

## Yield and composition of pasture grass.

BY H. P. ARMSBY, H. J. PATTERSON AND GEORGE L. HOLTER.

As noted above, the object of this experiment was to obtain data as to the chemical composition of pasture grass and the amount produced per acre, as a basis for comparison with soiling crops. The general plan of the experiment originated with the director ; the execution and a considerable part of the calculations were in the hands of Messrs. Patterson and Holter, Mr. Patterson having charge of the experiment until his resignation, in June, and Mr. Holter after that date. Having no pastures, it was necessary to find some spot which should represent as nearly as might be an average pasture. For this purpose a portion of the college campus was selected where the grass did not appear particularly luxuriant or, on the other hand, especially thin. The grass was an old blue grass sod with a quite liberal admixture of white clover, having a gradual slope to the southeast. A plat one rod wide and seven rods long was staked out, and subdivided into seven portions, each one rod square. The grass upon this plat was cut with a lawn mower, having attached to it a grass box which caught all or practically all the grass as it came from the knives. The sub-plats were cut in this way, one at a time, in regular rotation throughout the season. The object of sub-dividing the plat into seven sub-plats was to follow the daily rate of growth as closely as possible, and the intention was to cut one sub-plat each day. It was soon found, however, that daily cutting was too frequent, and during nearly all of the experiment the time of cutting was governed by the rate of growth of the grass. Each sample after cutting was taken at once to the laboratory, where it was weighed and an aliquot (one-third) taken for air-drying. The weight of each air-dry sample was taken. after it had stood for several days at the ordinary temperature of the laboratory, and each successive set of seven air-dry samples, representing one cutting of the entire plat, was united to form one analysis sample. With some of the last samples this order was varied somewhat, through a misunderstanding, in two cases three samples and in another case five samples being united.

**Composition of grass.** In all, 18 analyses were made, the first set of samples having been lost. The following are the results, calculated on the water-free substance.

## COMPOSITION OF GRASS.

| Period. | Dates of cutting. | | | | | | | Water. | In 100 parts of dry matter. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Ash. | Albuminoids. | Non-albuminoids. | Crude fiber. | N.-free extract. | Fat. |
| 1 | 5–16 | 5–17 | 5–19 | 5–19 | 5–19 | 5–21 | 5–22 | Samples lost. | | | | | | |
| 2 | 5–25 | 5–28 | 5–29 | 5–30 | 6– 1 | 6– 1 | 6– 4 | 75.22 | 9.22 | 19.76 | 0.50 | 20.75 | 43.86 | 5.91 |
| 3 | 6– 6 | 6– 7 | 6– 8 | 6–9* | 6–9* | 6–11 | 6–12 | 72.05 | 10.18 | 20.55 | 0.93 | 19.98 | 41.72 | 6.64 |
| 4 | 6–13 | 6–14 | 6–16 | 6–16 | 6–18 | 6–20 | 6–22 | 70.67 | 9.65 | 18.84 | 2.90 | 18.62 | 44.16 | 5.83 |
| 5 | 6–25 | 6–26 | 6–27 | 6–29 | 6–30 | 6–30 | 7– 2 | 71.61 | 9.41 | 20.09 | 2.61 | 17.66 | 43.26 | 6.97 |
| 6 | 7– 3 | 7– 4 | 7– 6 | 7– 7 | 7– 7 | 7–10 | 7–11 | 69.99 | 9.18 | 21.05 | 0.28 | 17.25 | 45.67 | 6.57 |
| 7 | 7–13 | 7–14 | 7–14 | 7–16 | 7–17 | 7–19 | 7–20 | 72.93 | 8.98 | 22.15 | 0.86 | 14.87 | 47.26 | 5.88 |
| 8 | 7–21 | 7–23 | 7–25 | 7–26 | 7–28 | 7–28 | 7–29 | 73.54 | 9.06 | 20.92 | 2.04 | 15.93 | 45.80 | 6.25 |
| 9 | 7–30 | 7–31 | 8– 1 | 8– 2 | 8– 3 | 8– 6 | 8– 7 | 65.57 | 9.04 | 19.31 | 2.51 | 16.39 | 46.11 | 6.64 |
| 10 | 8– 8 | 8– 9 | 8–13 | 8–14 | 8–15 | 8–16 | 8–20 | 60.61 | 8.51 | 18.76 | 1.24 | 17.08 | 48.03 | 6.38 |
| 11 | 8–22 | 8–23 | 8–24 | 8–25 | 8–25 | 8–27 | 8–28 | 70.41 | 8.60 | 23.95 | 1.68 | 14.60 | 43.37 | 7.80 |
| 12 | 8–29 | 8–30 | 9– 1 | 9– 1 | 9– 3 | 9– 4 | 9– 5 | 74.40 | 9.00 | 23.96 | 1.53 | 13.75 | 44.02 | 7.74 |
| 13 | 9–10 | 9–10 | 9–10 | 9–11 | 9–12 | 9–13 | 9–14 | 74.61 | 9.47 | 24.10 | 1.27 | 14.04 | 45.35 | 5.77 |
| 14 | 9–18 | 9–18 | 9–18 | 9–18 | 9–21 | 9–21 | 9–21 | 73.92 | 9.18 | 23.49 | 2.51 | 14.28 | 44.71 | 5.83 |
| 15 | 9–22 | 9–22 | 9–24 | 9–27 | 9–28 | 9–28 | 9–29 | 72.06 | 9.57 | 21.57 | 1.26 | 14.39 | 46.87 | 6.34 |
| 16 | 9–29 | 10– 2 | 10– 2 | —— | —— | —— | —— | 74.97 | 10.74 | 21.22 | 3.22 | 14.71 | 43.93 | 6.18 |
| 17 | —— | —— | —— | 10–15 | 10–15 | 10–17 | —— | 67.90 | 11.37 | 19.32 | 2.04 | 14.17 | 47.38 | 5.72 |
| 18 | 10–17 | 10–18 | 10–18 | 10–22 | —— | —— | 10–17 | 62.21 | 11.09 | 19.88 | 0.40 | 14.42 | 48.14 | 6.07 |
| 19 | 10–30 | 11– 2 | 11– 4 | 11– 5 | 10–30 | 10–30 | 10–30 | 63.58 | 11.31 | 18.66 | 2.14 | 14.05 | 47.48 | 6.36 |
| | Maxima | | | | | | | 75.22 | 11.37 | 24.10 | 3.22 | 20.75 | 48.14 | 7.80 |
| | Minima | | | | | | | 60.61 | 8.51 | 18.66 | 0.28 | 13.75 | 41.72 | 5.72 |
| | Average | | | | | | | 73.37 | 9.23 | 20.85 | 1.04 | 18.25 | 44.39 | 6.24 |

*Samples lost.

The samples, whose analyses are given in the foregoing table, while they are all young grass, represent somewhat different stages of growth, the number of days between the successive cuttings having varied from seven days to over three weeks. It will be observed that the composition varies not inconsiderably in the different samples, and some interest attaches to a study of these variations, both among themselves and in relation to external conditions. In making this study, the results upon each ingredient were platted upon cross-section paper, and compared with each other and with the more important meteorological elements, represented in the same way. Considerable time was spent in this study, but no very definite relations, either among the several ingredients themselves or between the percentage of any one ingredient and the meteorological conditions, were traced. In a general way there is an inverse correspondence between the percentage of crude fiber and of total protein and albuminoids. The minimum percentage of crude fiber coincides with the maximum percentage of total protein. The maximum percentage of crude fiber coincides with a percentage of total protein but slightly above the minimum. Upon comparing the graphic representations of the percentages of these two ingredients, a general inverse correspondence between the two curves was noted up to about period 16, although with considerable difference in the details. After that time the percentage of protein decreases, while that of crude fiber remains nearly constant. The relation between crude fiber and albuminoids appears to be substantially the same as between crude fiber and total protein.

The percentage of nitrogen-free extract varies in the opposite direction from that of total protein in every case but one, although the variations are by no means proportional. After period 8, there is a quite close inverse correspondence of the curves. No obvious relation could be traced between the percentage of non-albuminoids and that of any other ingredient. The percentage of fat in most cases rises and falls along with that of total protein, but not proportionally. The maxima and minima of the curves for total protein and for albuminoids show a sort of general correspondence with the highest and lowest percentages of water in the fresh substance, although the details of the two curves are quite different.

The study of the relation of the composition of the grass to external conditions also failed to show any marked correspondences. The points considered were, average length of periods, rain-fall and temperature. In regard to the first of these, the curve representing average length of periods showed no correspondence with any of the curves representing the composition of the grass, and it was evident that the length of period alone was not a determining factor. It is generally stated, and with truth, that the percentage of protein in a fodder decreases, and the percentage of crude fiber increases as the plant grows older. In this experiment, however, it was evident that this effect was masked by some other influences, for, in nine cases out of 17, the percentage of total protein increases as the average length of period increases, while, in six cases out of 17, the percentage of crude fiber decreases with increasing length of period. In 10 cases out of 17, the percentage of non-albuminoids decreases with increasing length of period. Scarcely any of these variations, however, are proportional. No definite relations could be traced between temperature or rain-fall and the composition of the grass, except that the curve representing the percentage of ash showed a general inverse correspondence with the curve of temperature. On the whole, the correspondences noted above are so few and uncertain that it has not been thought worth while to reproduce the diagrams here. In order, however, to enable any who wish, to follow out this branch of the subject, there is given in the following table the figures for rain-fall and temperature. The figures given for temperature were obtained by averaging the mean daily temperatures from the middle of one period to the middle of the succeeding period. Thus the average of the mean daily temperatures from the middle of period one to the middle of period two was 61° F. The rain-fall is computed as follows; taking that of period two as an illustration: the first sub-plat was cut for the first time May 16th, as shown by the table, and for the second time May 25th. The amount of rain falling on it during this time was noted from the meteorological records of the station. In like manner the rain-fall upon the second sub-plat, from May 17th to May 28th, was noted, that on the third plat from May 19th to May 29th, and so on with the others. The average of the seven numbers thus obtained for the rain-fall upon the seven sub-plats is taken to represent the average rain-fall corresponding to period 2. The other numbers of the table are computed in the same manner.

AVERAGE RAIN-FALL AND TEMPERATURE FOR THE SEVERAL PERIODS.

| Period. | Average of actual rain-fall on each sub-plat. Inches. | Temperature from middle to middle of period. Degs. Farenheit. |
|---|---|---|
| 2 | 2.62 | 61.0 |
| 3 | 0.52 | 62.2 |
| 4 | 0.23 | 70.0 |
| 5 | 1.75 | 75.3 |
| 6 | 0.51 | 67.2 |
| 7 | 1.74 | 67.9 |
| 8 | 0.72 | 69.2 |
| 9 | 0.25 | 75.2 |
| 10 | 1.48 | 72.6 |
| 11 | 3.24 | 68.6 |
| 12 | 0.88 | 66.5 |
| 13 | 1.56 | 60.2 |
| 14 | 1.50 | 60.4 |
| 15 | 0.41 | 60.2 |
| 16 | 0.39 | 55.9 |
| 17 | 0.85 | 45.2 |
| 18 | 1.42 | 46.1 |
| 19 | 1.37 | 45.6 |
| Range.................................. | 0.23—3.24 | 45.2—75.3 |

The average composition of the grass produced in this experiment is given in the following table. This average is not the average of the individual analyses, but is computed from the total yield per acre of the several ingredients, as recorded on a subsequent page, and hence represents the composition of the yield for the whole season. For comparison there are given the only three analyses on record, so far as we have been able to find, of grass at a stage of development corresponding to that in these experiments. They are as follows: Weiske[1] mixed clover and grass plucked by hand 13 times during the season, in imitation of pasturing; Wolff[2], meadow grass, cut April 24, 1874 and May 14, 1877.

COMPOSITION OF PASTURE GRASS.

| | Our experiments. | | Weiske. | Wolff. 1874. | Wolff. 1877. |
|---|---|---|---|---|---|
| | Fresh. | Water-free. | | | |
| Water | 73.37 | —— | —— | —— | —— |
| Ash | 2.46 | 9.23 | 12.91 | 9.01 | 9.00 |
| Albuminoids | 5.54 | 20.85 | 27.06 | 25.06 | 18.97 |
| Non-albuminoids | 0.28 | 1.04 | | | |
| Crude fibre | 4.85 | 18.25 | 16.74 | 18.10 | 24.70 |
| Nitrogen-free extract | 11.81 | 44.39 | 42.09 | 38.05 | 43.91 |
| Fat | 1.69 | 6.24 | 5.09 | 5.88 | 3.42 |
| | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |

Our pasture grass contained somewhat less crude protein and somewhat more crude fibre than Weiske's or than Wolff's sample of 1874, while Wolff's sample in 1877 was inferior to ours in chemical composition.

Pasture grass, as shown by these figures, is very rich in protein, and contain a comparatively small proportion of fibre, resembling, in the dry state, more nearly the grains than the ordinary coarse fodders. Of the total nitrogen of our sample, only 4.98 per cent. was found on the average to be present in the non-albuminoid form (as determined by Stutzer's method). Wolff[3] gives the average proportion of total nitrogen in a non-albuminoid form in four samples of pasture grass as 26.9 per cent.

**Digestibility.** We were not able to make any direct determinations of the digestibility of the grass in this experiment. In the experiment upon the value of green compared with dried grass, which is reported below, the digestibility of grass by a cow was determined. This grass was cut at a later stage of growth than the pasture grass of this experiment. As will be seen, by comparing the analysis, it differed from it considerably in composition, containing only 15 percent. of albuminoids in the digestion period, and less than 20 per cent. in the preliminary feeding, while the percentage of crude fibre was, in the two periods respectively, about 28 and 24 per cent. It is to be presumed, therefore, that the digestion co-efficients obtained are too low to represent fairly the digestibility of the very young grass of this experiment. At the same time, as we have no other figures, so far as the writer is aware, for the digestibility of American pasture grass, the co-efficients obtained in that experiment are made the basis of calculation for this experiment. They are as follows, compared with the co-efficients obtained by Weiske[1] and Wolff[2] with sheep for the samples whose composition was given above.

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[1] Wolff: Ernährung Landw. Nutzth., p. 108.
[2] *Landw. Jahrbücher*, VIII, Supplement I, p. 54.
[3] Mentzel and V. Lengerhe's Kalender, 1888, I, p. 90.

DIGESTIVE CO-EFFICIENTS OF PASTURE GRASS.

| | Our expt. Older grass. | Weiske. | Wolff. 1874. | Wolff. 1877. |
|---|---|---|---|---|
| Dry matter... | 70.13 | 75.4[2] | 67.90 | 65.16 |
| Ash... | 52.81 | —— | 17.07[3] | 12.64[4] |
| Total protein... | 68.66 | 78.2 | 79.13 | 73.29 |
| Albuminoids... | 59.55 | —— | —— | —— |
| Crude fibre... | 75.58 | 67.2 | 74.97 | 79.50 |
| Nitrogen-free extract... | 73.07 | 78.3 | 74.93 | 75.65 |
| Fat... | 57.48 | 64.2 | 63.40 | 65.44 |

The results of Weiske's and Wolff's experiments are considerably higher for crude protein, notrogen-free extract and fat than are our co-efficients, while their results for ash are strikingly lower. In view, however, of the fact that their co-efficients were obtained with a different species of animal, and of the uncertainity as to the influence of climatic and other differences upon the digestibility of our grass, it has been thought preferable, on the whole, as has been stated, to use on our co-efficients in the calculations on subsequent pages. We hope to be able, ere long, to replace these with others drawn from actual determinations of the digestibility of pasture grass by sheep and cattle.

**Yield per acre.** From the data given above, we can compute the rate of yield per acre of our plot, both of green grass, of dry matter, and of the various ingredients of which that dry matter is composed. Before presenting the results of this calculation, however, it seems desirable to say a word as to the value of the results reached. The term pasture has a very wide range of meaning. It may be applied, as it often is in New England, for example, to a rough, rocky, hillside which is used as pasture because no other use can be made of it. At the other extreme stand the rich lowland pastures of northern Europe, which furnish a great abundance of feed, and are regularly used for the fattening of cattle. Between these two extremes we may have all degrees of productiveness. Furthermore, the yield of the same pasture will vary according to the season. It is evident then that no single result like this can be said to represent the yield per acre of pasture in general. In the nature of things it is impossible to find what is the yield per acre of pasture. All that any results can show is what was produced under a certain set of circumstances. The sod upon our plat was rather thin; the rain-fall was greater than the average, except during June, when it was notably deficient, but on the other hand the rain-fall was less evenly distributed than usual, the number of days on which rain fell being less than the average, with the exception of April, May and October.

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[1] *Loc. cit.* [2] *Loc. cit.*, pp. 44 and 58.

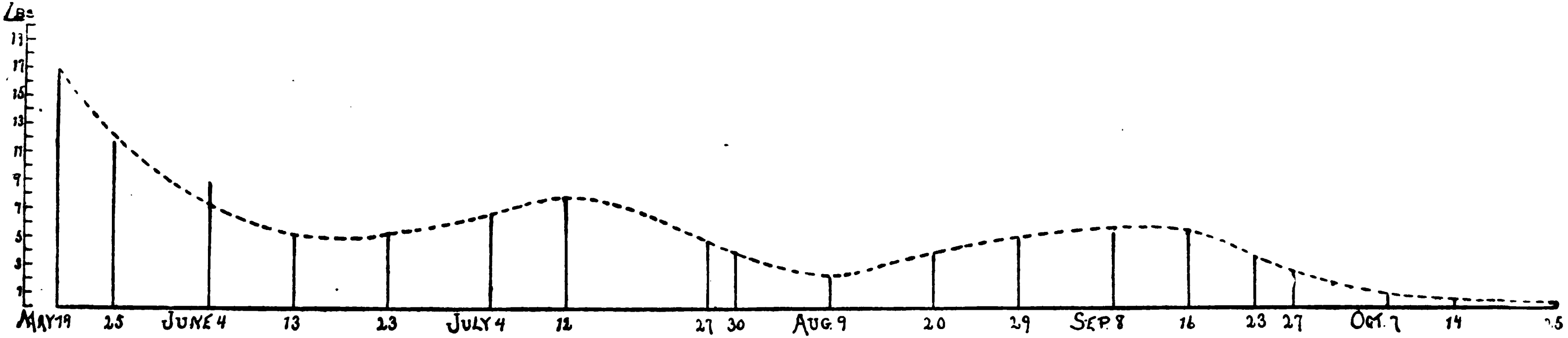
[2] Organic matter.

[3] Computed by writer.

[4] Computed by writer from average excretion of two animals. One of the animals showed an apparent negative digestibility.

| | Total rain-fall—inches. | | No. of days on which rain fell. | |
|---|---|---|---|---|
| | 1880–'84. | 1888. | 1880–'84. | 1888. |
| April | 1.93 | 2.79 | 8 | 10 |
| May | 4.23 | 6.26 | 12 | 17 |
| June | 4.70 | 2.61 | 12 | 7 |
| July | 2.41 | 2.78 | 10 | 6 |
| August | 2.83 | 6.16 | 8 | 6 |
| September | 2.21 | 3.12 | 7 | 4 |
| October | 2.34 | 3.76 | 8 | 13 |

Furthermore, the grass was probably kept cut too close to fairly represent good pasture not too heavily stocked. In a repetition of the experiment we should consider it desirable to cut much less frequently. Taking the results as they stand, and for what they are worth, we find the total yield of green grass per acre, from the beginning of the season to October 25th, to have been 4276.81 lbs., and that this amount of green grass contained 1145.49 lbs. of dry matter. The following table shows the total yield per acre in each period, both of fresh substance, total dry matter, and the several ingredients of the latter. In computing the yield of digestible matter the digestion co-efficients given above have been used. The non-albuminoids are not given separately in this table, but are included with the protein. As was noted in connection with the table of the composition of the grass, the samples of period 1 were lost. In the table, the grass for this period has been assumed to have had the same composition in the air-dry state as that of the next succeeding period.



RATE OF GROWTH OF DRY MATTER OF PASTURE GRASS.

| Period. | Yield in pounds. Per acre. | | | | | | | Digestible. | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh sub-stance. | Dry matter. | Ash. | N×6.25 | Crude fibre. | N.-fr. extr'ct. | Fat. | N×6 .25 | Car-bohy-drates. | Fat. |
| 1 | 1300.00 | 339.10 | 31.25 | 68.74 | 70.37 | 148.70 | 20.04 | 47.09 | 162.24 | 11.53 |
| 2 | 525.40 | 130.12 | 11.99 | 26.37 | 27 01 | 57.06 | 7.59 | 18 35 | 61.80 | 4.41 |
| 3 | 325.20 | 90.90 | 9.25 | 19.52 | 18.20 | 37.90 | 6.03 | 13.58 | 41.46 | 3.65 |
| 4 | 139.80 | 40.69 | 3.93 | 8.85 | 7.58 | 17.96 | 2.37 | 6.06 | 18.80 | 1.36 |
| 5 | 228.60 | 64.85 | 5.71 | 14.63 | 11.45 | 28.53 | 4.53 | 10.13 | 29.36 | 2.60 |
| 6 | 170.60 | 49.90 | 4.58 | 10.64 | 8.61 | 22.79 | 3.28 | 7.40 | 23.05 | 1.88 |
| 7 | 246.70 | 66.61 | 5.99 | 15.32 | 9.90 | 31.48 | 3.92 | 10.50 | 30.36 | 2.25 |
| 8 | 170.40 | 45.10 | 4.09 | 10.36 | 7.19 | 20.63 | 2.82 | 7.10 | 20.44 | 1.62 |
| 9 | 101.30 | 33.79 | 3.05 | 7.37 | 5.54 | 15.59 | 2.24 | 5.05 | 16.12 | 1,18 |
| 10 | 104.70 | 23.42 | 1.99 | 4.68 | 4.00 | 11.26 | 1.49 | 3.09 | 11.62 | 0.63 |
| 11 | 145.00 | 42.92 | 3.69 | 11.00 | 6.26 | 18.62 | 3.35 | 7.54 | 18.25 | 1.92 |
| 12 | 147.40 | 37.74 | 3.40 | 9.62 | 5.19 | 16.61 | 2.92 | 6.50 | 16.72 | 1.48 |
| 13 | 216.30 | 52.48 | 4.96 | 13.31 | 7.37 | 23.81 | 3.03 | 9.24 | 22.92 | 1.74 |
| 14 | 202.40 | 52.75 | 4.85 | 13.72 | 7.53 | 23.58 | 3.07 | 9.48 | 22.88 | 1.78 |
| 15 | 84.29 | 23.55 | 2.25 | 5.39 | 3 38 | 11.04 | 1.49 | 3.79 | 10.64 | 0.86 |
| 16 | 85.40 | 21.35 | 2.29 | 5.22 | 3.14 | 9.38 | 1.32 | 3.58 | 9.21 | 0.77 |
| 17 | 31.90 | 11.06 | 1.26 | 2.36 | 1.57 | 5.24 | 0.63 | 1.62 | 5.01 | 0.36 |
| 18 | 42.70 | 16.03 | 1.78 | 3.25 | 2.31 | 7.71 | 0.98 | 2.25 | 7.35 | 0.56 |
| 19 | 8.72 | 3.13 | 0.35 | 0,66 | 0.44 | 1.50 | 0.20 | 0.45 | 1.41 | 0.11 |
| Total. | 4276.81 | 1145.49 | 106.66 | 251.01 | 207.04 | 509.40 | 71.40 | 172.79 | 529.64 | 40.69 |

**Rate of growth.** The above figures show the yield per acre throughout the season. It is desirable to know also the daily rate of growth at different seasons. In the first period it is plain that we must assume a date when the growth began since the yield obtained represents the total growth up to the time of cutting. In the following table it has been assumed to represent the growth of 20 days. In the subsequent periods each number represents the average of the seven sub-plats. The date given is found as follows: The date of cutting the first sub-plat, and the date of the last previous cutting of the same sub-plat being known, the number of days between these two dates gives the number of days' growth represented by the yield of that sub-plat, and a date half way between the two dates given above would be the one to which the average rate of growth might be assigned. By going through the same proceeding with each of the seven sub-plats, and averaging the results, we get the number of days' growth represented by the yield of the seven sub-plats, and the date to which the average rate of growth is to be assigned.

AVERAGE DAILY YIELDS.—LBS. PER ACRE.

| Period. | Average date of cutting. | Fresh matter. | Dry matter. | Ash. | Protein (N×6.25). | Crude fiber. | N.-fr. ext. | Fat. | Digestible. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Protein. | Carbohydrates. | Fat. |
| 1 | May 19 [assume 20 days' growth] | 65.00 | 16.95 | 1.56 | 3.44 | 3.52 | 7.44 | 1.00 | 2.35 | 8.11 | 0.58 |
| 2 | May 30. . . . . | 47.18 | 11.68 | 1.08 | 2.37 | 2.43 | 5.11 | 0.69 | 1.65 | 5.55 | 0.40 |
| 3 | June 9. . . . . | 32.52 | 9.09 | 0.93 | 1.95 | 1.82 | 3.79 | 0.60 | 1.36 | 4.15 | 0.37 |
| 4 | " 17. . . . . | 17.18 | 5.00 | 0.48 | 1.09 | 0.93 | 2.21 | 0.29 | 0.74 | 2.31 | 0.17 |
| 5 | " 28. . . . . | 20.00 | 5.67 | 0.50 | 1.28 | 1.00 | 2.49 | 0.40 | 0.89 | 2.57 | 0.23 |
| 6 | July 7. . . . . | 20.23 | 5.92 | 0.54 | 1.26 | 1.02 | 2.71 | 0.39 | 0.88 | 2.73 | 0.22 |
| 7 | " 16. . . . . | 26.56 | 7.17 | 0.64 | 1.65 | 1.07 | 3.39 | 0.42 | 1.13 | 3.27 | 0.24 |
| 8 | " 25. . . . . | 17.81 | 4.71 | 0.43 | 1.08 | 0.75 | 2.16 | 0.29 | 0.74 | 2.14 | 0.17 |
| 9 | Aug. 3. . . . . | 12.66 | 4.22 | 0.38 | 0.92 | 0.69 | 1.95 | 0.28 | 0.63 | 2.02 | 0.15 |
| 10 | " 14. . . . . | 9.52 | 2.13 | 0.18 | 0.43 | 0.36 | 1.02 | 0.14 | 0.28 | 1.06 | 0.06 |
| 11 | " 26. . . . . | 12.84 | 3.80 | 0.33 | 0.97 | 0.55 | 1.65 | 0.38 | 0.67 | 1.62 | 0.17 |
| 12 | Sept. 2. . . . . | 19.12 | 4.90 | 0.44 | 1.25 | 0.67 | 2.16 | 0.38 | 0.84 | 2.17 | 0.19 |
| 13 | " 12. . . . . | 21.94 | 5.32 | 0.50 | 1.35 | 0.75 | 2.41 | 0.31 | 0.94 | 2.33 | 0.18 |
| 14 | " 19. . . . . | 25.75 | 6.71 | 0.62 | 1.75 | 0.95 | 3.00 | 0.39 | 1.21 | 2.91 | 0.23 |
| 15 | " 25. . . . . | 12.56 | 3.51 | 0.36 | 0.80 | 0.50 | 1.63 | 0.22 | 0.56 | 1.59 | 0.13 |
| 16 | " 26 (3 plats) | 10.25 | 2.56 | 0.27 | 0.63 | 0.38 | 1.12 | 0.16 | 0.43 | 1.11 | 0.09 |
| 17 | Oct. 7 (3 plats) | 1.88 | 0.65 | 0.07 | 0.14 | 0.09 | 0.31 | 0.04 | 0.10 | 0.29 | 0.02 |
| 18 | " 11 (5 plats) | 1.64 | 0.62 | 0.07 | 0.13 | 0.09 | 0.29 | 0.04 | 0.09 | 0.28 | 0.02 |
| 19 | " 25. . . . . | 1.21 | 0.44 | 0.05 | 0.09 | 0.06 | 0.21 | 0.03 | 0.06 | 0.20 | 0.02 |

The diagram given herewith represents to the eye the variations in the rate of growth at different times during the season, the length of the vertical black lines being proportional to the daily rate of growth of dry matter at the several dates. It is evident both from the table and the diagram that there is a rapid falling off after the early spring growth, doubtless exaggerated somewhat in this case by the dry weather of June, and possibly by the too frequent cutting. Still the results are such as might be reached on fully stocked pasture. The point most worthy of notice is the great variation in the yield at different times, it being from five to eight times as great in early spring as in August. The result of this is that if a pasture is stocked to its full capacity in the spring, it is overstocked in midsummer, and both the pasture itself and the yield of the herd suffer. On the other hand, if only so much stock is placed on the pasture as it can carry throughout the season, the early spring growth is not utilized. The only way in which this difficulty can be overcome is by supplementing the pastures with other feed during the summer, either in the form of soiling or of grain feed.

It is difficult to state what was the average daily yield in this experiment, owing to the uncertainty as to what should be considered the length of the season. If, however, we assume that the grass was fit to pasture on May 10th, and reject the very small yields after September as of no account, we have the season extending from May 10th to September 29th, or 142 days. During this time, the average daily growth was as shown below :

| AVERAGE DAILY GROWTH FOR WHOLE SEASON. | LBS. PER ACRE. |
|---|---|
| Fresh grass | 25.17 |
| Total dry Matter | 7.70 |
| Ash | 0.71 |
| Albuminoids | 1.61 |
| Non-albuminoids | 0.08 |
| Crude fiber | 1.41 |
| N.-fr. extract | 3.42 |
| Fat | 0.48 |
| DIGESTIBLE. | |
| Albuminoids | 1.08 |
| Non-albuminoids | 0.08 |
| Carbohydrates [fiber and nitrogen-free ext.] | 3.57 |
| Fat | 0.27 |
| Total digestible organic matter | 5.00 |

No obvious relation could be traced between the daily rate of growth, and either the length of period, daily mean temperature, or rain-fall.

## Effect of drying on the digestibility and nutritive value of grass.

BY H. P. ARMSBY AND WM. H. CALDWELL.

Numerous experiments have shown that the digestibility of a fodder is in nowise decreased by drying, provided care is taken that no portion of the fodder is lost in the process. The claim is frequently made, however, by practical men, familiar with the great difference between the nutritive values of, for example, pasture grass and hay, that while the dried material may be as digestible as the green it has not an equal nutritive effect. While there are no sufficient grounds for this claim, there is not on record, so far as the writer is aware, any experiment in which a direct comparison is made of the actual nutritive effect of fodder of the same quality, green and dried. The following experiment is an attempt to test this latter point, while supplying additional data upon the question of relative digestibility. It was attempted also to utilize the experiment for the purpose of obtaining figures for the digestibility of American pasture grass. The experiment was necessarily made upon a small scale, owing to the difficulty of obtaining the necessary material in sufficient quantity The attempt was made to secure grass approximately like that cut from the small plat, described in the foregoing paper. At first the clippings obtained from the college campus by the horse lawn mower were used. Later, owing to the comparatively slow growth of the grass, and the difficulty experienced in securing a sufficient quantity in this way, spots were selected upon the campus on which the grass was sufficiently long to be cut with the scythe, although still comparatively young. This grass, of course, differed considerably in composition from the very young grass cut from the plots, and, as already pointed out, was presumably somewhat less digestible, but it was as close an approximation to pasture grass as the circumstances permitted us to obtain.

The general plan of the experiment, and the discussion of the results, are the work of the director; the execution of the plan is to be credited to Mr. Caldwell, and the chemical analyses of fodder, dung, and milk were made by Messrs. Patterson, Holter and Sweetser, assistant chemists of the station.

**Plan of the experiment.**—The animal used was a five year old Guernsey-Jersey cow. She dropped her second calf on Apr. 2, 1888. The week previous to entering upon the experiment her average daily yield of milk was 29 lbs. and 3 oz. On May 11th, '88, she was fed ten lbs. of the green grass, and the quantity of grass increased and that of dried fodder decreased, until May 27th, when she was fed exclusively green grass, of which she received a full ration of 80 lbs. The experiment proper began on the afternoon of May 29th, and was conducted as follows: On the afternoon of each day there was cut on the college campus somewhat more than 165 lbs. of grass. The grass was raked up carefully as fast as cut, placed in a cart, and kept covered to prevent wilting, and taken to the barn as soon as the whole quantity had been cut. There a sample of about five lbs. was first taken for chemical analysis; then 80 lbs. were weighed out for the animal, about half being given to it the same night, and the remainder kept covered in as cool a place as possible and used for the next morning's feed. Finally a second portion of 80 lbs. was weighed out and spread on a large sheet to dry. It was at first attempted to dry this grass in the sun, but this was found to progress so slowly that, as a substitute, a staging was built over a steam boiler and the sheet containing each day's grass was spread out upon this and allowed to lie, usually for nearly 24 hours. When thoroughly dried, the whole amount for one day was carefully transferred to a cloth bag, tied up securely and set aside. This routine was gone through with daily throughout the first period of 18 days. During the last five days of this period the digestibility of the grass was determined in the method described below. The weight of the cow, and the amount of water drunk daily were determined; the cow was not allowed to run in the yard but kept in the stable throughout the experiment. In the second period of the experiment, also extending over 18 days, the dried grass from the previous period was fed, the grass dried on the first day of the first period being fed on the first day of the second period, and so on throughout. The digestibility of the dried grass was determined during the last five days of the period, and the weights of the animal and of water drunk were taken as before. Throughout the experiment the animal was milked twice daily. Each milking was weighed and, after mixing, equal volumes of the night's and next morning's milk were taken and mixed together for analysis. The feed given was eaten clean except on five days of the green grass feeding. Four of the days were in the first half of the period, and all five of them in what may be called the preliminary feeding; that is, there were no uneaten residues during the digestion period.

It should be observed that in an experiment conducted in this way, practically all the errors of experiment are likely to diminish rather than to increase the comparative value of the dried grass. The green grass was weighed out and fed directly, with practically no chance for loss. The dried grass, on the contrary, had been handled considerably, and since it was not weighed after drying, any accidental loss during the drying and necessary handling, would diminish the amount of food eaten in the second period, and so tend to cut down the milk yield. It is believed, however, that no material loss of fodder occurred during the experiment.

**Composition of grass.**—The sample of five lbs. of grass which was taken daily during the feeding with green grass, as noted above, was conveyed at once to the laboratory, where it was accurately weighed on a balance sensitive to 0.5 grm., and air-dried. When dry the samples were allowed to stand for several days at the temperature of the laboratory, and then the 13 samples representing the preliminary feeding and the five samples representing the actual digestion period, after being weighed on the same balance were united to form the analysis samples.

During the feeding with green grass, uneaten residues were left as follows:

| | |
|---|---|
| May 31 | 1786 grms. |
| June 1 | 1446 " |
| " 5 | 1063 " |
| " 6 | 1871 " |
| " 7 | 1162 " |

These residues dried out considerably before they were collected. When reduced to the original water-content of the grass, they amount to

| | |
|---|---|
| 1st half of period (May 31–June 6) | 9521 grms. |
| 2d " " " (June 7) | 1796 " |
| | 11317 |

Making the amount of fresh grass actually eaten per day as follows:

1st half of period 35262 grms., = 77.71 lbs.
2d " " " 36120 " = 79.62 "
Whole period 35691 = 78.66.

These uneaten residues were sampled exactly as described above for the fodder.

During the feeding with dried grass no samples of fodder were taken, since the analyses of the green grass represented with equal accuracy the composition of the dry matter of the dried grass. No uneaten residues occurred during the dried grass feeding with the exception of insignificant amounts of foreign matter, sticks, etc. on four days of the preliminary feeding. The details of the air-drying of the samples of fodder and residues are given in the appendix to this paper which will be published in the December number. The following table shows the proportion of water and dry matter, and the percentage composition of the dry matter of the grass that was used in the preliminary feeding and in the digestion period, and of that left uneaten.

COMPOSITION OF GRASS.

| | Preliminary feeding. | Digestion period. | Uneaten residues. |
|---|---|---|---|
| Water | 73.21 | 75.77 | 58.61 |
| Dry matter | 26.79 | 24.23 | 41.39 |
| | 100.00 | 100.00 | 100.00 |
| In 100 parts of dry matter. | | | |
| Ash | 10.31 | 10.92 | 10.47 |
| Albuminoids | 13.44 | 11.74 | 13.25 |
| Non-albuminoids | 6.29 | 3.43 | 4.68 |
| Crude fiber | 24.33 | 27.92 | 24.92 |
| Nitrogen-free extract | 41.12 | 41.73 | 41.62 |
| Fat | 4.51 | 4.26 | 5.06 |
| | 100.00 | 100.00 | 100.00 |

The dried grass as fed contained 13.98 of water.

It will be observed that the grass used in the preliminary feeding was of rather better quality than that used in the actual digestion period, since it contained considerably more protein and considerably less crude fiber. It is altogether probable that there was a difference in the digestibility corresponding to this difference in composition, and that more food was actually digested from the grass during the first part of the experiment than appears from the figures to be presented later. On the other hand, however, this difference affects both periods of the experiment equally, since grass of the same quality was fed at a corresponding time in each period. By this method of conducting the experiment, therefore, we eliminate from the comparison of the nutritive effects any error due to the varying composition of the grass on different days.

**Digestibility.**—As noted above, the digestibility of both the green and the dried grass was determined. A watchman was stationed with the cow day and night. The dung was caught on a shovel and transferred to a galvanized iron box. The total excretion for 24 hours was weighed daily at noon, carefully mixed, sampled, and an amount equal to 1–50 of the total excretion was air-dried in steam closet at a moderate temperature. The air-dry samples were allowed to stand at the ordinary temperature of the laboratory for several days, and then the samples for each period, after being weighed, were united to form the analysis sample. The urine of the animal was caught in a pail and thrown away. Sawdust was used for bedding, and any fodder which was scattered by the animal was readily picked up and returned to the manger by the watchman. The following table shows the daily weights of fresh and of air-dry dung. The weights of air-dry dung are the best measure we have of the regularity of excretion, since separate determinations of hygroscopic moisture were not made upon the daily samples. It will be seen that the variations from day to day are not greater than would be expected:

| Period I. | | | | | | Period II. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Fresh Dung. Grms. | Sample of air-drying. Grms. | Dried weight of sample. Grms. | p. ct. | Air-dry matter excreted. Grms. | | Fresh dung. Grms. | Sample for air-drying. Grms. | Dried wt. of sample. Grms. | p.ct. | Air dry matter excreted. Grms. |
| Jun. 12 | 20180 | 398 | 63 | 15.82 | 3193 | Jun. 30 | 15610 | 424 | 65 | 15.33 | 2392 |
| " 13 | 21660 | 425 | 60 | 14.12 | 3059 | July 1 | 18880 | 372 | 59 | 15.86 | 2995 |
| " 14 | 19050 | 376 | 60 | 15.96 | 3040 | " 2 | 18060 | 356 | 56 | 15.38 | 2776 |
| " 15 | 21460 | 423 | 63 | 14.89 | 3197 | " 3 | 16730 | 351 | 56 | 15.95 | 2669 |
| " 16 | 18490 | 374 | 62 | 16.58 | 3066 | " 4 | 16800 | 331 | 54 | 16.31 | 2740 |

It was stated above that in sampling the dung, 1-50 of the daily excretion was taken for air-drying. This is not strictly true. Owing to an error in converting the weights as taken in pounds and ounces into grammes, slightly less than 1–50 was taken. This however, alone, does not affect the results, but in three cases, viz., June 16, June 30 and July 4, the proportion taken varies considerably from that on the other days. This is especially the case with the sample of June 30. The consequence is that, while the computation of dry matter excreted is not affected at all, this sample is given undue weight in making up the analysis sample. In view, however, of the unlikelihood of there being any great variations in the composition of the dry matter of the dung from day to day, it is believed that this error cannot have materially affected the results of the digestion experiment.

The chemical composition of the united samples of dung was as follows:

FRESH DUNG.

| | Period 1. | Period 2. |
|---|---|---|
| Water | 86.72 | 85.38 |
| Dry matter | 13.28 | 14.62 |
| | 100.00 | 100.00 |

DRY MATTER.

| | | |
|---|---|---|
| Ash | 17.55 | 16.97 |
| Protein | 16.73 | 15.05 |
| Crude fiber | 22.98 | 22.65 |
| N. fr. extract | 36.58 | 39.41 |
| Fat | 6.16 | 5.92 |

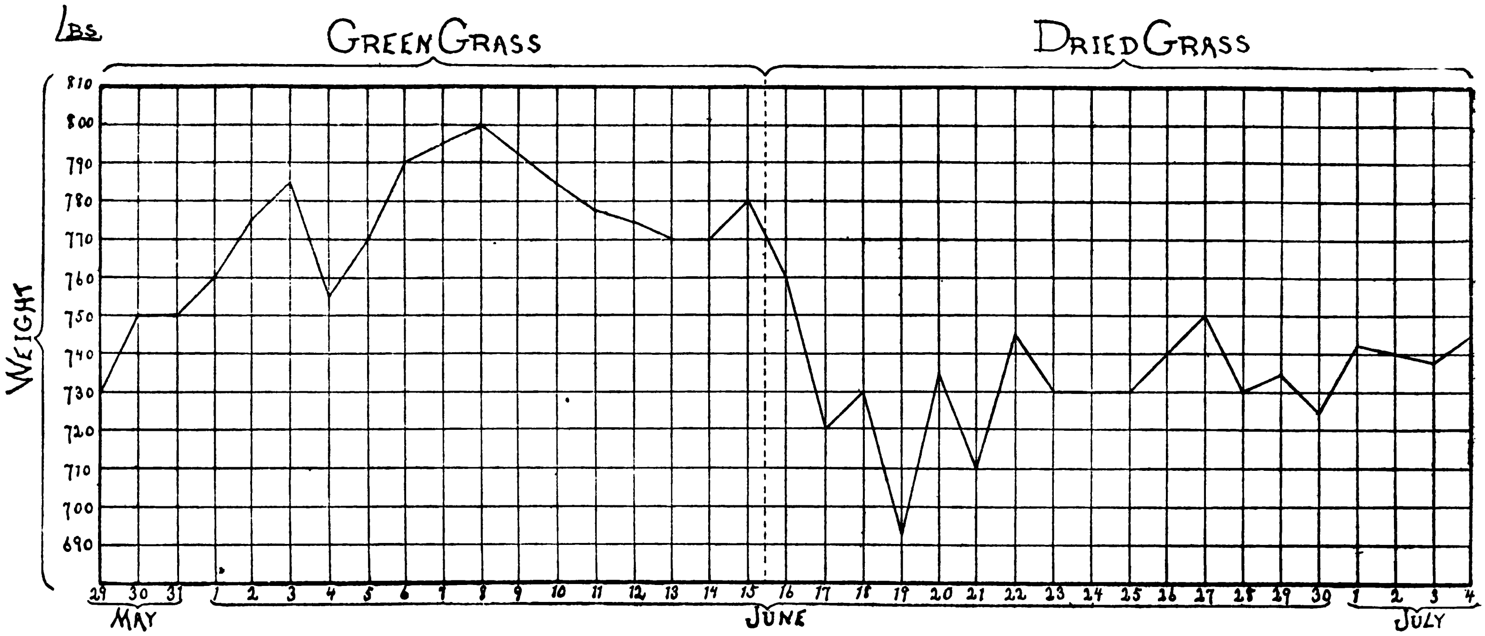
The following table, based upon the above data, shows the results of the digestion experiments:

DIGESTIBILITY.

| | Fresh matter. | Dry matter. | Ash. | Total protein. | True albuminoids. | Crude fiber. | N. Fr. Ext. | Fat. |
|---|---|---|---|---|---|---|---|---|
| Period I. | | | | | | | | |
| Fed | 36287 | 8792 | 961 | 1334 | 1033 | 2454 | 3669 | 374 |
| Excreted | 20165 | 2738 | 480 | 458 | [458] | 629 | 1002 | 169 |
| Digested | | 6054 | 481 | 876 | [575] | 1825 | 2667 | 205 |
| Pr. ct. digested | | **68.87** | **50.05** | **65.66** | **55.68** | **74.37** | **73.18** | **54.73** |
| Period II. | | | | | | | | |
| Fed | [36287] | 8792 | 961 | 1334 | 1033 | 2454 | 3669 | 374 |
| Excreted | 17213 | 2516 | 427 | 378 | [378] | 570 | 992 | 149 |
| Digested | | 6276 | 534 | 956 | [655] | 1884 | 2677 | 225 |
| Pr. ct. digested. | | **71.39** | **55.56** | **71.66** | **63.42** | **76.78** | **72.95** | **60.06** |
| Average | | **70.13** | **52.81** | **68.66** | **59.55** | **75.58** | **73.07** | **57.48** |

The results just given, show an apparently greater digestibility for the dried than for the green grass. A portion of this difference may arise from the method in which the experiment was conducted, as will appear from the following considerations: If any of the grass was lost during the process of drying, the amount of material actually fed in the second period was less than that in the first period. In the computations as to the digestibility, however, it is assumed that the same amount of material was fed in the two periods. If this is not the case, the amount excreted in the dung in the second period as actually determined, being deducted from a greater amount than was actually fed, will show a correspondingly greater digestibility. It is reasonably certain, however, that not all the difference in the two sets of figures is due to this cause. In order to produce the observed difference in the digestibility of the dry matter, it would have been necessary that fully 20 per cent. of the grass should have been lost in drying. It is impossible that any such loss as this can have taken place, and most of the difference must be explained in some other way. On the other hand it is difficult to imagine that the drying can have actually increased the digestibility, and the writer is inclined to consider the observed difference as simply accidental and most probably due to variations in the amount of dung excreted. The results at any rate agree with those of other experimenters in so far as they show that no loss of digestibility results from simple drying.

**Nutritive effect.**—The nutritive effect of the feeding is to be



VARIATIONS OF LIVE WEIGHT.

measured by the gain or loss in weight of the animal and by the milk yield.

*Live weight:* The average live weight of the animal in the first and second halves of each period is presented in the following table which contains also the average amount of water drunk per day, and the average stall temperature.

For daily weighings see appendix in the December number of this magazine.

| | Average live weight. | Average water drunk. | Average stall temperature. |
|---|---|---|---|
| Period I. Green grass. | | | |
| 1st half | 763 lbs. | 67.5 lbs. | 67.9 degs., Fahr. |
| 2d " | 783 " | 54.2 " | 71.8 " " |
| Whole | 773 " | 60.9 " | 69.9 " " |
| Period II. Dried grass. | | | |
| 1st half | 728 " | 106.1 " | 78.1 " " |
| 2d " | 742 " | 106.9 " | 68.4 " " |
| Whole | 735 " | 106.5 " | 73.30 " " |

In order to show better the variations of live weight, the weights from day to day have been represented graphically on the accompanying diagram. It is evident from the figures for the daily weighings, and from an inspection of the diagram, that while the weight of the animal was decidedly less in the second period, on the dried grass, than in the first period, the falling off of weight in passing from the one period to the other was a sudden one. Within three or four days after the dried grass feeding was begun, the weight practically reached its minimum, and thereafter increased rather than decreased. If the apparent loss of weight in the second period had been due to deficient nutrition, we should expect that the falling off would be gradual. The fact that it was not, indicates pretty conclusively that the loss was not due to actual decrease in the weight of the tissues of the animal, but to a decrease in the contents of the stomach and intestines due to the change of food. This appears so plain from the diagram, that I believe we are safe in assuming that the green grass showed no material superiority over the dried grass, so far as the maintenance of the animal was concerned.

*Quality of milk:* The average percentage composition of the milk produced in each half of each period is shown below. For details, see appendix.

PERCENTAGE COMPOSITION OF MILK.

| | Total solids. | Fat. | Protein. [N.×6.25.] |
|---|---|---|---|
| Period I. Green grass. | | | |
| First half | 12.84 | 4.10 | 2.76 |
| Second half | 12.29 | 4.19 | 2.80 |
| Whole | 12.57 | 4.14 | 2.78 |

| | | | |
|---|---|---|---|
| Period II. Dried grass. | | | |
| First half | 12.07 | 4.17 | 2.65 |
| Second half | 12.27 | 4.27 | 2.58 |
| Whole | 12.17 | 4.21 | 2.62 |

The table shows slight changes in the composition of the milk, but they are rather favorable than otherwise to the dried grass. The percentage of solids decreases somewhat regularly until the second half of the dried grass period, when it rises again. The fat shows an increase, although a somewhat irregular one, throughout the experiment, and the protein a decrease after the first half of the first period. On the whole, the differences are so small as to be of little significance.

*Quantity of milk:* The table below shows the average daily yield of milk in each half of each period, and also the average yield per day of total solid matter, of fat and of protein calculated from the composition of the milk as just given. For details, see appendix.

AVERAGE DAILY YIELD.

| | Fresh milk. Grms. | Total solids. Grms. | Fat. Grms. | Protein. [N×6.25.] |
|---|---|---|---|---|
| Period I. Green grass. | | | | |
| First half | 11869 | 1524 | 487 | 328 |
| Second half | 11724 | 1442 | 491 | 328 |
| Whole | 11797 | 1483 | 489 | 328 |
| Period II. Dried grass. | | | | |
| First half | 11466 | 1384 | 478 | 304 |
| Second half | 11466 | 1408 | 489 | 296 |
| Whole | 11466 | 1396 | 483 | 300 |

The quantity of fresh milk produced per day decreases in general throughout the first period, and the first half of the second period. During the second half of the dried grass feeding this falling off is arrested, although no increase is produced. Taking the solids as our basis of comparison, we find that between the first half and the second half of the first period, the daily yield decreased 82 grms.; between the second half of the green grass period and the first half of the dried grass period, it fell off 58 grms.; while between the first half and the second half of the dried grass period we note an increase of 24 grms. The daily yield of fat is a matter of some interest since it furnishes us an approximate measure of the amount of butter which the milk might have produced. As will be seen, the yield of fat is very nearly uniform throughout the experiment, there being but a slight falling off in the first half of the dried grass period. The yield of protein is less in the second period than in the first. On the whole the figures appear to show a slight increase in the milk production in the last half of the dried grass period, although the differences are small. If they are to be accepted as significant, we may say that the nutritive effect of the dried grass was slightly greater than that of the green grass. It is to be remembered, however, that a little of the green grass was left uneaten in the first period while the dried grass in the second period was eaten clean so that the cow really received a trifle more food in the second period than in the first. Taking this into account, a fair calculation from the above results would appear to be that the green grass and the dried grass were substantially equal in nutritive effect.

It was not possible in this experiment to determine the actual yield of butter from the milk. The amount of fat contained in the milk may, of course, be taken as an approximate measure of this, but as will be shown below, this measure is not an exact one. The churnability of milk, that is, the proportion of its total fat which can be recovered in butter, may vary considerably, it would appear, under the influence of the food eaten. Further mention on this point will be made in connection with the experiment about to be described.

(*To be concluded.*)

Pennsylvania state college agricultural
experiment station, state college, Sept., 1889.

## LETTERS TO THE EDITOR.

### BULLETIN NO. 8 OF THE MISSOURI AGRICULTURAL EXPERIMENT STATION.

In your issue for September occurs a criticism of bulletin No. 8 issued by me, for the Missouri state experiment station. We should all welcome competent, impartial and conclusive criticism, as such is for the good of science and for the public interests. In the public interest which AGRICULTURAL SCIENCE serves, I wish to mildly dissent from the following language: "Certainly, with such evidence, this bulletin should not find a place in scientific discussion."

The trial had its unfortunate limitations which I faithfully called public attention to, and therefore it should call for the reverse of the following remark by the editor, viz.: "For these establish a lack of confidence in the accuracy of the entire work." It is true that political chaos in the station gave us a chemist for which I was not responsible, and whose full capacity was absorbed in the university, although one-half of his salary was drawn from the station. The work that he failed to do, as noted in the bulletin, will not entitle you to challenge his competence as to the work that was done, unless you have outside facts that will admit of it. Now the only weakness of the trial is over his work, which I could not control. I do not propose to defend the chemistry of the trial. Dr. Schweitzer can do that if he chooses. But when his work is thrown entirely out, the balance stands a solid and fair test of ensilage on a plan never before tried, and has even then, scientific value, and as I believe, a very high practical value.

The public are concerned in knowing whether the trial is a sound one, and what it soundly shows, inasmuch as the result was not favorable to ensilage versus dry fodder. The criticisms, outside of those of the chemistry of the trial, have no force. This point I desire to show. You quote my statements, as follows: that "this material was not suitable for the trial." "By an oversight they (the cows) were not weighed by the party in charge of the trial until Dec. 24th, while the trial began Dec. 12." "With all of the errors and imperfections of the trial."

The unsuitable material was unsuitable to determine the absolute value of the food in growth, because grown by my predecessor too thick in the drill, the drills being too near together, but one-half of this food was put in the silo, and the other half in the barn in the air-dry state, and was suitable for a comparative test of ensilage against dry fodder of the same material. There was no occasion for me to mention it in the bulletin, except as an apology for the growth of steers, if too low. As a comparative test, which it was, it was perfectly fair and flawless. Second, in regard to the weighing referred to above; it was due to the failure of my assistant to weigh the cows at the start, by 12 days, but the trial was continued that much time longer, and we have their gain or loss for the actual time fed under weight, which certainly involves no guessing nor fallacy. My statement of imperfections, referred to the chemical work, which was a source of deep annoyance to me. I regard the whole relation of the chemist to the question as a gross outrage upon the station on the part of someone. I know that the university saved the money. I do not wish to be held responsible for that which I condemned.

I believed that there was sound matter of value to the public, and held myself to be a fair judge on that point, and should not have given it had I not so regarded it. What then is there of the trial, of value beyond controversy?

(1.) The cost of storage capacity for food in both the green and dry state was shown, and was found to be the cheapest for dry storage. (2) The total loss of ensilage in pounds by scale weights, and by layers, was shown tô be 19.16 per cent. (3) It was shown that fodder corn could be dry stored with slight loss in a compact body. (4) It was shown that a limestone silo preserves ensilage better, or as well as the weighed results of others who have reported for the wood silo. (5) It was shown that it cost less to put the air-dry half of the food in the barn, than it did to put the other half in the silo. (6) Sixth and of most importance, it was shown that one-half of a given lot of green fodder corn put into the barn, after air drying, lasted much longer than an equal amount of green food put into the silo. These lots, half and half, went each way in storage and when fed, chemistry out and the cows and steers eating away oblivious of the fact that our chemist was drawing a salary from the station, while teaching lawyers, doctors, etc., actually ate up by a marked and vital period all there was of the ensilage, before the dry half was gone, and gave as good results from the dry fodder cows. (7) Sugar corn proved better for cows and poorer for steers, than field fodder corn. (8) Cows fed on dry fodder, gave the best churning milk, and the richest milk. (9) The butter from the dry fodder was the best. (10) The cows maintained their live weight best on dry food.

These points, ten in number, do not involve the chemist at all. But the station had obtained an assistant chemist before the close of the trial, and valuable chemical work was done, of whose quality I have no reason to doubt. But the ten points named, were secured with great care and full accuracy. In fact I regard them as bomb proof, and venture to say that they will stand the test of future experimenters. The further hint of the trial, that the ensilage gave a more watery produce, will be found well taken in both steers and cows, by investigators.

I might say much for the chemistry, but there is little call for it. In fact, the sampling of foods in green fodder and ensilage, so that a slight variation will not occur and thus vitiate the figures all of the way through is almost impossible, for the slightest variation in the [illegible] analyzed, becomes so great when applied to tons, that I should regard the best analytical work as only a valuable auxiliary aid in so delicate a matter as this question of green versus dry food.

fodder

In conclusion, allow me to say that the points given above, were found under conditions that I challenge successful criticism of, and I hope that you will kindly consent to give them to the public over my name, and let future work disprove them. I am the more anxious that you should do so, because the position before the public of the writer, the ensilage question, has been somewhat apart from others, and one to which I am willing to stand officially committed before the public. I believe that the method pursued by me, of packing one-half of a lot of fodder corn in the dry state, in the barn in a compact body, is the only true method of critically testing ensilage versus dry fodder. This I believe to be the first test in this manner, and of interest for this reason if no other.

J. W. SANBORN.

Columbia, Mo., Oct. 7.

## RECENT LITERATURE.

COMMISSIONER OF AGRICULTURE, Report of the, 1888, pp. 708, plates numerous. Washington : Government, 1889.

When we consider that England has but just succeeded in establishing a government agricultural department, we cannot but feel how much behind us the mother country is in promoting her agricultural interests, as compared with the lusty son. At the present time the United States department of agriculture wields a much greater influence towards uplifting American agriculture than most of those who casually glance over this report imagine. It requires but little examination of the report, however, to demonstrate that this document is made up of a class of matter which reflects credit upon the department, the report, and the work being done by the officers in charge. And instead of being simply a seed distributing bureau, as many seem to think, the fact is that at least six of the ten divisions of the department are contributing in a striking manner towards original research in agricultural science. Further, so great is the influence of some of these, that to-day we find the divisions of chemistry, entomology, botany, and economic ornithology in the hands of such capable scientists, as to give the work of the department unquestionably high standing all over the world.

To be sure criticism can be made, but notwithstanding this, we believe the report to be a credit to the country. In view of the change of administration in governmental affairs, it is an excellent showing that so little has been done of a political nature towards upsetting and injuring this great wing of a political machine.

Without reference to the divisions or officers controlling the work, the following interesting subjects among others are reported upon, and embrace more or less important research conducted by the department: "The plum curculio (*Conotrachelus nenuphar*, Herbst.)." "The fluted scale (*Icerya purchasii*, Maskell)." "The hop plant-louse (*Phorodon humuli*, Schrank)." "On various methods for destroying scale insects." "Prevention of hog cholera." "Lard and its adulterations." "Experiments in the manufacture of sugar." "Experiments in the treatment of grape vine diseases made in 1888." "The food of crows."

## PUBLICATIONS RECEIVED.

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AMERICAN POMOLOGICAL SOCIETY, Proceedings of the twenty-second session of the, Held in Ocala, Florida, Feb. 20, 21, 22, 1889, pp. 171+liv. Compiled by the secretary, A. A. Crozier. Published by the society, 1889.

ARKANSAS INDUSTRIAL UNIVERSITY AGRICULTURAL EXPERIMENT STATION, Fayetteville, Ark. Bulletin No. 11, Sept., 1889, pp. 11. Strawberries. Wheat. Oats.

BOLLEY, Henry L. The heterœcesmal pucciniæ, pp. 169–180, fig. 7. Extracted from the *American monthly microscopical journal*, x, 1889.

CANADA, Central experimental farm, department of agriculture, Ottawa. Bulletin No. 5, August, 1889, pp. 23, fig. 25. Strawberry culture.

CANADA, Ontario department of agriculture. Agricultural college. Bulletin xlv, Sept. 20, 1889, pp. 7. Ontario oats. xlvi. Oct. 1, 1889, pp. 6. Chess.

CORNELL UNIVERSITY, college of agriculture. Bulletin of the agricultural experiment station. Horticultural department. IX. September, 1889, pp. 87–110, fig. 3. A study of windbreaks in their relations to fruit growing.

ILLINOIS, University of. Agricultural experiment station. Champaign, August, 1889, pp. 165–176, fig. 1. Bulletin No. 6. A bacterial disease of corn.

INDIANA, Bulletin of the agricultural experiment station of Indiana. Purdue university. No. 28, September, 1889, pp. 23, fig. 7. Smut of wheat and oats.

KENTUCKY AGRICULTURAL EXPERIMENT STATION, of the state college of Kentucky. Bulletin No. 21, September, 1889, pp. 22. Wheat experiments. The grain louse.

KEW, Royal gardens. Bulletin of miscellaneous information. No. 33, September, 1889, pp. 217–236. CVI. Flowers of Calligonum as an article of food in N. W. India. CVII. Earliest notice of Cocoa. CVIII. Buazé fibre. CIX. Vegetable productions, central China. CX. Vine cultivation in the Gironde. CXI. Phylloxera in South Africa. CXII. Erroneous report of phylloxera in Greece.

MAINE AGRICULTURAL EXPERIMENT STATION. Bulletin No. 2, second series, pp. 7. The apple maggot (*Trypeta pomonella*, Walsh.) The potato rot (*Peronospora infestans* Mont.)

MICHIGAN, Agricultural college of. Experiment station. Bulletin No. 53, August, 1889, pp. 8. Entomological department. Spraying with arsenites. Bulletin No. 52, July 1889, pp. 7. Chemical department. Commercial fertilizers.

NEBRASKA, University of. Bulletin of the agricultural experiment station of Nebraska. Nos. 7, 8, 9, 10, June, 1889, pp. 267, plates IX. Original investigations of cattle diseases in Nebraska, 1886–1889.

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION. Bulletin No. 64, July, 1889, pp. 19. I. Practical stock feeding on scientific principles, together with its relations to chemistry.

OHIO AGRICULTURAL EXPERIMENT STATION, Bulletin of the. Vol. II, No. 3. Second series, No. 10, June, 1889, pp. 73–100, figs. 30–37. Article V--Silos and ensilage. Article VI—Ensilage vs. field beets as food for cows. Vol. II, No. 5. Second series, No. 12, August, 1889, pp. 115–132. Article IX—Experiments in wheat seeding. Article X—Comparative tests of varieties of wheat.

UNITED STATES DEPARTMENT OF AGRICULTURE. Office of experiment stations. Experiment station bulletin No. 3, July, 1889, pp. 12. Report of a meeting of horticulturists of the agricultural experiment stations, at Columbus, Ohio, June 13, 14, 1889.

UNITED STATES DEPARTMENT OF AGRICULTURE. Office of experiment stations. Experiment station bulletin No. 2. Digest of the annual reports of the agricultural experiment stations in the United States for 1888, pp. 258. Part 1. June, 1889.

UNITED STATES DEPARTMENT OF AGRICULTURE. From the annual report of the department of agriculture for the year 1888. Report of the botanist, Dr. Geo. Vasey, for the year 1888, pp. 305–324, plates XIII.

UNITED STATES DEPARTMENT OF AGRICULTURE. Office of experiment stations. Circular No. 11. Rules for naming vegetables. Report of committee of experiment station horticulturists. September, 1889, pp. 3.

# ABSTRACTS.

## SUCCESSFUL OPERATION FOR THE CURE OF LARYNGISMUS PARALYTICUS OR ROARING IN THE HORSE.

(By J. S. BUTLER : *Jour. comp. med. and surg.*, x, pp. 329–31.)

This was carried out according to Fleming's method. The horse was a gelding, at least 20 years old, that had a chronic discharge from the nasal passages, with considerable rattling in those passages and the trachea. The least exertion would cause very loud roaring, and with severe exertion, staggering.

The animal was thrown and secured, and in 10 minutes a suitable stage of anesthesia reached. The hair was clipped as closely as possible over the region of the larynx, the skin sponged with solution of hydrargo-bichloride, then an incision about five inches in length made in the median line through the skin and muscles, exposing the larynx and trachea. The hemorrhage was controlled by cold water sponging and torsion of some vessels. When hemorrhage had entirely ceased, the larynx was opened together with the first two rings of the trachea. Considerable mucus mixed with pus escaped from the wound coming up from the trachea and bronchi.

The true cause of roaring in this case was fully shown, as the left arytenoid cartilage was perfectly immovable, and the muscles of the same side were plainly atrophied, while the right arytenoid and muscles were in a normal condition, and expanded and contracted at each respiratory act.

The left vocal cord was severed from its anterior attachment, and it with the arytenoid cartilage was entirely removed. All partially detached pieces of tissue and shreds of mucus membrane were taken away by the means of curved shears. As the hemorrhage was slight it was not thought necessary to pack the trachea. What hemorrhages ensued were controlled by cold water antiseptically treated with hydrargo-bichloride, applied with small silk sponges attached to the end of pieces of whalebone.

The wound was left open as advised by Fleming. After the animal had sufficiently recovered from the anesthetic, he was allowed to arise and walk to the barn. A piece of gauze was tied about his neck, covering the wound, and kept wet with the antiseptic solution, and a little of the solution was injected in the wound.

No food or water was allowed for 36 hours, when a few swallows of water and a little bran and oatmeal gruel were given, which were swallowed without much difficulty. The diet was confined to gruel for several days, when a little grass was allowed.

On the ninth day after the operation the larynx was found in a good condition, and in four weeks was about healed. Six weeks after the operation the author and two other veterinarians put the halter to the horse and ran him up hill and down, and tried him otherwise, but without producing any roaring.

## THE EFFECT OF ROOT ACTION ON THE VITALITY OF PASTURE PLANTS.

(By WM. FREAM: *Gard. chron.*, vi, 146, p. 416.)

This is an abstract of a paper read by Prof. Fream before the British association for the advancement of science.

In the course of some investigations into the herbage of old grass-lands (see AGR. SCIENCE, III, p. 68) which the author carried out last year, turfs nine inches in depth were dug from a number of old pastures in England and Ireland, and transferred to one and the same place, where they were planted to permit of growth and observation. The species growing upon each turf were identified, and, after careful separation, the specific constituents of the herbage were severally weighed and tabulated.

In the discussion that followed the publication of the results, it was argued that certain grasses, conspicuous by their infrequent appearance and small percentages on these turfs, had been killed by cutting at so shallow a depth as nine inches.

While admitting the established fact that certain plants send their roots to a considerable depth, it appeared to the author that some confusion had been made between root range on the one hand, and the effects of root section on the other. To settle the point at issue, the following plants were selected: *Alopecurus pratensis*, *Avena elatior*, *Dactylis glomerata*, *Elymus condensatus*, *Festuca pratensis*, *Phleum pratense*, *Trifolium pratense*, *Medicago sativa*, *Taraxacum officinale*, *Achillea millefolium* and *Plantago lanceolata*.

These plants were dug up in early spring, their roots were well washed, and then the roots and root-fibres were cut through with scissors at various depths below the surface. Several specimens of each plant were taken, and the length of root after cutting never exceeded three inches, and sometimes was as little as one inch. The various specimens were then planted out in poor soil, and they not only lived, but in the course of the summer they all came into bloom. The test was far more severe than in the case of the nine-inch depths of turf, where there was no transplanting in the true sense of the word. *Elymus condensatus* and *Medicago sativa* are not British pasture plants, but the former was employed because it is a grass far more robust and of much stouter roots than any British grass; its roots were severed at a depth of between one and one-half and two inches. The latter is a notoriously deep-rooted plant, and the section of its roots was made at a depth of three inches. The experiment shows that root section, even of very deep-rooted plants, may be performed without fatal results at exceedingly moderate depths. The practical interest of the point at issue is, that it underlies a subject of very great agricultural importance.

## CITRIC ACIDS IN THE MILK OF COWS.

(By F. SONLHET: *Wiener landw. Zeit.*, 1888, p. 401.)

Citric acid made part of the normal composition of cows' milk. Analyses of a great number of samples from different provinces, gave from 1.8 to 2.2 gr. of citrate of lime and 0.9 to 1. gr. citric acid in one litre of milk. It is therefore concluded that an average litre of milk contains one gram of citric acid, or one part in 1,000. A good milch cow will furnish daily as much citric acid as exists in two or three lemons.

The concretions that are frequently found in condensed milk are nearly pure citrate of chalk. Human milk does not contain but little. It is possible that their difference or composition exists in a general way between the milks of herbiverous and carniverous animals.

The discovery of citric acid in milk fills a regrettable gap. We know in fact that the serum of milk holds in solution a quantity of lime greater than that which is held by the mineral acids and bases, and through the above this fact naturally explains itself.

The citric acid of milk proves without doubt that the vegetable food of the cow, either as dry or green fodder, contains a more or less proportion of this acid and also other vegetable acids, which appear during the fermentation of the cellulose.

*Ab.: Annales agronomiques, xv, p. 430.*

## UPON THE DURATION OF THE GERMINATIVE FACULTY OF AGRICULTURAL SEEDS.

(By J. SAMEK : *Bied. Centr.*, xviii, p. 285.)

The author determined the germinative power of seeds from one to five years old that had been preserved in paper sacks in a dry and warm locality. The figures given express the number of seeds grown from 100 placed in the test. The first figures indicate seed one year old, the second two years old, etc., in succession. The numbers placed between parentheses express the per ct. of diminution of the germinative faculty, after five years' keeping :

| | | | | | | |
|---|---|---|---|---|---|---|
| Red clover | 95, | 96, | 95, | 89, | 82, | |
| " " | 85, | 83, | 81, | 80, | 65, | (18.) |
| Hybrid " | 73, | 64, | 51, | 37, | 15, | (79.) |
| White " | 74, | 72, | 63, | 52, | 50, | (32.) |
| Sainpoin | 87, | 92, | 78, | 61, | 54, | (35.) |
| Lucern | 98, | 95, | 98, | 81, | 79, | (23.) |
| Tall oat grass | 70, | 66, | 59, | 43, | 24. | |
| " " " | 92, | 91, | 87, | 77, | 66, | (31.) |
| English rye grass | 73, | 80, | 75, | 66, | 41, | (51.) |
| Italian " " | 74, | 68, | 70, | 60, | 55, | (38.) |
| Sheeps fescue | 73, | 66, | 61, | 55, | 32, | (40.) |
| Foxglove | 13, | 8, | 8, | 6, | 5, | (38.) |
| *Fleole* | 96, | 93, | 92, | 88, | 81, | (9.) |
| Orchard grass | 41, | 47, | 44, | 44, | 38, | (7.) |
| *Paturin des près* | 28, | 16, | 17, | 17, | 16, | (43.) |

The following is the number of seeds that lived in case of pure cereals, well ripened, preserved in glass jars for eight years:

Padua maize, 56, oats, 25, barley, 28, wheat, 0, rye, 0, flax, 0, lucern, 60.

*Ab.: Annales agronomiques, xviii, p. 431.*

## PASSAGE OF GASES THROUGH PLANTS.

(By WIESNER and MOLLISCH : *Phar. post.*, Sept. 22, p. 681.)

This is an abstract of a communication recently presented to the Vienna academy of sciences by the authors. They have found that neither living nor dead vegetable cell-membrane allows dry gases, even under pressure, to filter through, either when the membrane is dry, or when saturated with moisture, but that the movement of gases in plants is a process of diffusion, which goes on more rapidly in proportion as the cell-membrane is saturated with water. The greatest amount of diffusion takes place when the membranes of algæ, or of submerged water plants, act as dialytic diaphragms. Carbonic acid diffuses through the membrane more rapidly under similar conditions than hydrogen, oxygen or nitrogen; generally speaking the rapidity with which gases diffuse through the cell-membrane is dependent upon the absorption, co-efficient, and density of the gas. Further, carbonic acid diffuses out from vegetable cells more rapidly into air than into water, and probably the same holds good with other gases.

*Ab.: Gardener's chronicle, Oct. 12, 1889.*

### METHOSE.

(By O. LOEW: *Botan. Central.*, xxxvii, p. 416.)

At a recent meeting of the Munich botanical society, the author gave some new and interesting results which he had secured in carrying on his researches. It is known that formose, obtained from formic aldehyde, by the same formula as that of glucose, has a sweet taste, but is unfermentable. Another analogous body, but fermentable, likewise derived from formic aldehyde, has also been obtained, to which the author has given the name of methose. This artificial sugar more resembles levulose than dextrose.

*Ab.: Annales agronomiques, xv, pp. 421-2.*

## EXPERIMENT STATION ABSTRACTS.

### MILK ANALYSIS.

### A NEW VOLUMETRIC METHOD FOR THE DETERMINATION OF FAT IN MILK, SKIMMILK, BUTTERMILK AND CREAM.

(*First annual report of the New Hampshire experiment station, 1888, pp. 69-83.*)

[The following abstract is prepared by Mr. C. L. Parsons, assistant chemist to the New Hampshire station, the originator of the method described, and is a revision of the matter in the report.—ED.]

Many methods of greater or less efficiency have been devised for the volumetric analysis of milk. The author claims the following advantages for his method. The analysis of milk and cream from .20–45. per cent.; quickness and cheapness combined with accuracy; a large number can be done at once and the large amount of milk used (100 c. c.) and fat obtained greatly increase the limits allowable for error.

The following apparatus and solutions are required:

**Apparatus.**—1st. Three pipettes 100 c. c., 50 c. c., and 25 c. c., capacity each, the latter having the stem at least 23 cm. long. 2nd. A 10 c. c. measuring cylinder. 3rd. Measuring tubes calibrated from 0 to 5 c. c. in divisions of .05 c. c., 23 cm. long and of such an internal diameter that the distance on the scale from 0 to 5 shall be between 19 and 20 cm. The tube is enlarged at the top to admit the neck of the flask containing fat. 4th. Bottles made of transparent glass about 28 cm. high and 4 cm. in diameter and of a capacity of about 250 c. c. 5th. Flasks of about 70 c. c. capacity with the necks cut off obliquely about 1.5 cm. from the shoulder. The flasks should have no sharp angles and the necks should be, in order to prevent loss of fat by capillary attraction when turned into the tube, at least .5 cm. less external diameter than the tops of the tubes are internal. 1.3 cm. is a convenient size. 6th. A drying oven.

**Solutions.**—1st. Gasoline boiling between 27° and 60°.

2nd. Saturated solution of $Na\,O\,H$.

3rd. $C_2\,H_5\,O\,H$ (95%) containing about one per cent. of castile soap.

4. A little strong $H\,(C_2\,H_3\,O_2)$.

**Directions for analysis.**—Measure out 100 c. c. of the well mixed milk into one of the bottles, add 10 c. c. $Na\,O\,H$ sol., 5 c. c. alcohol soap sol., and 50 c. c. of gasoline. Shake vigorously for a few seconds, and again five or six times during the next half hour. If the gasoline solution does not now separate in a very few minutes, add 5 c. c. more of the alcohol sol., and as soon as bubbles cease to rise in quantity, turn the bottles slowly upside down and back again. This may be repeated if necessary, which is seldom the case. As soon as the upper solution is perfectly clear, draw out 25 c. c., taking great care that none of the lower solution enters. From the pipette let the solution run into one of the flasks and evaporate the gasoline. Dry at 120°–125° for an hour and a half. Now turn the fat slowly into one of the measuring tubes, previously placed in the oven and let the flask drip for ten minutes at the same temperature. Cool the measuring tube until the first appearance of the fat, solidifying, hold clasped in the hand a moment until the fat clears up, and then read off the number of c. c. from the upper surface of the meniscus. Ascertain the per cent. of fat from the tables.

Skimmilk and buttermilk are dried only three-quarters of an hour, if they contain less than one per cent. of fat. The fat from them is measured in a tube already half full of dried fat, the reading being obtained by difference.

In the case of cream, 100 c. c. are taken, diluted with 100 c. c. of water, and 50 c. c. of the mixture taken for analysis.

The separation in the case of whole milk or cream, generally takes place within ten minutes. Skimmilk and buttermilk generally require a longer time, but will always separate.

The film of fat left behind, after analysis, is always approximately the same, as in evaporating the gasoline it is each time washed down. Each flask should have this film before being used for analysis. Pure butter fat, containing no salt, should be used to form it whenever it is necessary to clean the flasks.

A convenient method, where steam can be had, for evaporating the gasoline is to bore some holes about the size of the bottoms of the flasks in the top of a small closed box, set the flasks containing the solution on these, and pass steam CAREFULLY into the box. This requires about five minutes for any number desired.

The measuring tubes can be easily cleaned with gasoline, while warm. Dry before using.

A simple drying oven can be made of tin, of any required size with a shelf containing holes for the measuring tubes 25 cm. from the bottom. The top should be at least 10 cm. above the shelf, and the thermometer bulb about 1 cm. A cover is preferable to a door.

One hundred and nine analyses of milk of individual cows, skimmilk, buttermilk and cream are given and compared with results by Soxhlet's method, and gravimetric analysis by the author and Mr. E. H. Farrington.

The method can be used by any intelligent dairyman and is already successfully applied in a few creameries.

Tables for fat in milk between .18 and 8.56 per cent. and in cream between 15. and 45.60 per cent. are given in the report. These are based upon the following formulæ:

$$\%\ \text{fat} = \frac{4560x}{103y}, \text{for milk, skimmilk and buttermilk.}$$

$$\%\ \text{fat} = \frac{4560x}{25y}, \text{ for cream.}$$

In which $x =$ No. of c. c. of fat found, and

$y = 25 - x.$

C. L. P.

## ANIMAL NUTRITION.

### SILAGE VS. FIELD BEETS AS FOOD FOR MILK PRODUCTION.

(*Ohio agricultural experiment station. Bull. No. 3, vol. II, pp. 89–100.*)

The object was to test the relative values of silage and field beets, or mangles, in the production of milk. Twelve grade short-horn cows, were divided into four lots of three each, and designated as A, B, C, D. It was proposed to give 10 lbs. of clover hay, two lbs. corn meal and four lbs. bran per day to each animal, and in addition to feed lot A 40 lbs. corn silage daily, per cow, and lot B 50 lbs. beets per cow, throughout the experiment, while lots C and D were to have the same rations as A and B, but in alternate periods of two weeks each.

The above rations were adjusted on the basis of German and early American analyses, supposing that silage contained 20 per cent. dry matter, and the beets 15 per cent. However, the silage showed 25 per cent. and the beets but 10. As the beet fed cows did not have enough to eat, their hay ration was increased five lbs.

The corn meal and bran were eaten up clean by all the cows throughout the test, and but seven pounds of beets were refused throughout the entire test. More or less silage was left by every cow fed upon it, and especially so towards the end of the experiment, when it appeared that 40 lbs. of silage might better have been fed, than 50.

The evidence from tests of the milk of the four lots at five different times during the experiment, was that the different rations did not have different effects upon the percentage of fat in the milk.

The following table is a summary of the results in pounds, and explains itself:

SILAGE VS. BEETS.

| Lot. | Average consumption of dry matter per period. | | | | Average produce per head per period. | | | |
|---|---|---|---|---|---|---|---|---|
| | On silage. | | On beets. | | On silage. | | On beets. | |
| | Per head | Per 1000 lbs. | Per head. | Per 1000 lbs. | Milk. | Flesh. | Milk. | Flesh. |
| A...... | 298.9 | 296.3 | .......... | .......... | 176.7 | +12.0 | ......... | ............ |
| B...... | ............ | ............ | 323.9 | 281.2 | ........... | ......... | 233.9 | +3.9 |
| C...... | 315 8 | 279.6 | 325.7 | 281.8 | 181.2 | +23.0 | 190.7 | —3 5 |
| D...... | 301.5 | 281.9 | 3233. | 298.2 | 203.4 | + 5.5 | 206.8 | +1.0 |

From the above data, it is evident that beets are better than silage for the production of milk, while for flesh formation, the value of the foods is reversed.

So far as capable of judging at present, about the same quantity of potential cattle food per acre may be produced from an acre of land, whether in beets or silage corn. The cost of production is uncertain, but it is believed that the cost of producing beets may be reduced to that of growing the corn.

## ECONOMIC ENTOMOLOGY.

### SPRAYING WITH THE ARSENITES.

(*Michigan agricultural experiment station. Bull 53, pp. 8.*)

Prof. Cook, with others, has for several years been experimenting with Paris green, to destroy the plum curculio. For six or seven years plum trees were sprayed once or twice without effect by himself, while his friends had very satisfactory results. Finally he concluded that as the plum is a smooth fruit, the poison would be very easily washed or blown off, so in 1888 certain trees were sprayed three times at intervals of eight days, with very marked results. He also found that one pint of crude carbolic acid to 50 lbs of plaster was efficient to repel the curculio. This year (1889) the experiments were repeated, but with no success, all the trees being severely attacked, and the plums lost, owing no doubt to the poison being washed off by the almost daily rains. However, the author believes that the arsenites and carbolized plaster will protect against the plum curculio if they can be kept on the tree or fruit. But during very frequent rains, the jarring method will be both cheaper and better. Where apples are badly stung, it is advised to plant plum trees in the orchard so that the curculio will concentrate itself upon the plum.

Prof. Cook cautions against spraying before the blossoms fall, else bees may be poisoned.

Experiments were carried on to give the effect of the arsenites upon the foliage of various kinds of trees. London purple was found to be more injurious to the foliage than Paris green; and white arsenic—arsenious acid—is more harmful than either. The colored water after London purple fully settles, was found to be very destructive to foliage, while analine was not at all harmful. Peach foliage was especially susceptible to injury, and cherry foliage the least so of any of the kinds treated.

London purple and white arsenic, used just before a rain, are more harmful than when used during a drouth. Spraying soon after the foliage puts out, is less harmful than when it is delayed a few days, or better a few weeks. London purple may be used on apple, plum, cherry, pear and most ornamental trees, but on these should never be stronger than one pound to 200 gallons of water. If the arsenites are to be used on the peach, to defend against the curculio, Paris green only should be used, and not over one pound to 300 gallons of water. With the peach, the poison is not only absorbed, coloring the tissue purple or brown, but even the petiole or stem of the leaf is weakened, and the leaf falls.

Tests were made to determine if the pasturage beneath sprayed trees was poisonous to an injurious degree. From chemical and practical tests, is is not thought to be dangerous.

## THE APPLE MAGGOT: TRYPETA POMONELLA.

(*Maine agricultural experiment station. Bull. No. 2, pp. 5.*)

This is a summary of two years' study by Prof. F. L. Harvey, of this station.

The perfect apple maggot (*Trypeta pomonella*, Walsh) is a two-winged fly, somewhat smaller than a house fly. From early in July, for six or eight weeks, the flies emerge from the ground in Maine, and soon begin to deposit eggs in early apples. Each female is capable of depositing over 300 eggs, which are inserted from time to time, one in a place beneath the skin of the apple. The maggots hatch in a few days, and become full grown in four to six weeks, when they are one-fourth inch long. The larvæ remains in the apples until they are ripe. Larvæ of several ages may be found in the same fruit. Soon after they mature the larvæ leave the apples and go into the ground an inch or so if favorable. In a short time they change to the pupa state and remain in that condition till the following spring, when the flies emerge again.

Spraying when the apples are small, before the flies appear is of no use. Poisoned sweets placed on paper in pans among the trees do not attract the flies. Sticky fly paper is useless to catch the flies.

The following methods are recommended as preventives: (1) Keep the orchards in grass, and in fall or spring burn under the trees to destroy the pupæ about the roots of grass. (2) Deep spading or plowing, if the orchard is in cultivation, will kill the maggots in spring. (3) As they are most affected, do not plant orchards on sandy soil and in sheltered places with southern exposure. (4) Prevent by legal measure the importation of foreign fruit from localities known to be infested.

For direct methods of restricting the maggot, the following are given: (1) Catch flies in bottles or tubes. The insects are easily caught. (2) Do not allow the larvæ in the fruit to transform, and destroy the windfalls. Infested apples in market places should be destroyed. Refuse could be buried a foot or so deep. (3) The destruction of the entire apple crop for one season in the infested districts of the state, by giving the flies no place to rear their maggots, would about destroy the pest.

## AGRICULTURAL PHYSICS.

### A STUDY OF WINDBREAKS IN THEIR RELATION TO FRUIT-GROWING.

(*Cornell university agricultural experiment station. Bull. ix, pp. 87–110.*)

This bulletin is the result of an investigation to learn (1) the influence of windbreaks upon fruit plantations, and (2) to ascertain proper location and manner of making windbreaks. Prof. Bailey sent out many circulars to fruit growers in New York and Michigan, asking for definite information, and received 77 replies. In conclusion, he gives the following general summary:

1. A windbreak may exert great influence upon a fruit plantation.

2. The benefits derived from windbreaks are the following: protection from cold; lessening of evaporation from soil and plants; lessening of windfalls; lessening of liability to mechanical injury

of trees; retention of snow and leaves; facilitating of labor; protecting of blossoms from severe winds; enabling trees to grow more erect; lessening of injury from the drying up of small fruits; retention of sand in certain localities; hastening of maturity of fruits in some cases; encouragement of birds; ornamentation.

3. The injuries sustained from windbreaks are as follows: preventing the free circulation of warm winds and consequent exposure to cold; injuries from insects and fungus diseases; injuries from the encroachment of the windbreak itself; increased liability to late spring frosts in rare cases.

(a.) The injury from cold, still air is usually confined to those localities which are directly influenced by large bodies of water, and which are protected by forest belts. It can be avoided by planting these belts.

(b.) The injury from insects can be arrested by spraying with arsenical poisons.

(c.) The injury from the encroachment of the windbreak may be averted, in part, at least, by good cultivation and by planting the first simultaneously with the belt.

4. Windbreaks are advantageous wherever fruit plantations are exposed to strong winds.

5. In interior places, dense or broad belts, of two or more rows of trees, are desirable, while within the influence of large bodies of water, these or narrow belts composing but a row or two, are usually preferable.

6. The best trees for windbreaks in the Northeastern states are Norway spruce, and Austrian and Scotch pines, among the evergreens. Among deciduous trees, most of the rapidly growing native species are useful. A mixed plantation, with the hardiest and most vigorous deciduous trees on the windward, is probably the ideal artificial shelter belt.

## PLANT DISEASES.

### A BACTERIAL DISEASE OF CORN.

(*Illinois agricultural experiment station. Bull. No. 6, pp. 165–176.*)

This disease is first noticed in the dwarfed condition of the young plants, occurring in spots commonly, of sizes varying from a few square rods to an acre or more. It is difficult to designate the special condition or quality of soil most associated with the diseases. The young diseased plants are smaller than the healthy ones, and are uniformly yellowish in color, the lower leaves showing most. The leaves rarely die, and wither chiefly at the ends and margins. In anything like severe cases, at least one-half the roots, always the lowest, are injured and usually dead. The bottom part of the stalk also dies early and if split longitudinally, through the middle, the inner tissue of the lowest part will be seen to have a uniform dark color. On the surface, brownish, corroded spots can be found, either strictly bordered or diffusely spreading. Sometimes masses of semi-transparent, rather firm, gelatinous material are found upon these external corrosions.

After midsummer, especially, the disease becomes more apparent through the leaf sheath discoloring. The sheaths may become spotted or have large, brown, irregular patches, of half rotten appearance, and occasionally there is a little reddish color. The evidence of injury is more apparent on the innerside of the sheath.

Finally, the ears are, at least occasionally, affected. Externally, the appearance of the outer husks is like that of the diseased leaf-sheaths. Internally, in the worst stage, the whole ear is reduced to a moist state of corruption, though not ill-scented. The parts lose their normal rigid or turgid quality, appear as if wilted, and are packed closely together. Very often these ears subsequently becomes mouldy, penetrated through by a close, very white, felt-like fungus.

In 1882 Prof. Forbes sent Prof. Burrill corn stalks and leaves collected in McLean county, Ill., thus affected by corroded spots, and chinch bugs. The latter were found to be infested with bacteria, which swept them off as by contagion. From 1882 to this date the disease has been in process of investigation.

The disease organisms are found in great numbers on and within the affected parts of the roots, the subterranean stem, leaf and ear. Often they collect on the surfaces in gelatinous lumps or masses.

The individual organisms are quite variable in shape, though usually cylindrical with a mixture of ovals, and are affected by red stain in a peculiar manner. One, or more often two, dot like portions, take a deep color, while the rest remains unstained. When these dots are near the middle, the extremities usually become less and less visible, until it is only possible to make out the terminal portions with a good objective, etc. However, when the bacteria have been grown in artificial cultures, they usually stain uniformly solid throughout.

The bacteria divide in one plane only, in the direction of the short axis. They are very commonly in couples, but rarely adhere in strings of greater numbers, and multiply most rapidly at 36° C.

Nutrient gelatine is not liquified by the bacteria. On the surface the growth spreads in a definitely bordered circle, commonly somewhat wavy, and is lustreless. On the sloping surface of an agar tube the growth is prompt and characteristic forming during 20–30 hours at 36° C. an opaque, lusterless, white streak with margins nearly even or regular. The mass is not entirely homogenous. In liquids the tube becomes uniformly turbid within 24 hours. No spores are formed in the tubes.

In fresh cultures of beef broth, the ovals average a little longer than they do when grown on solid media. The transverse measure, in all fresh cultures, is very nearly uniform, and is about .65 micron. The most common length of a newly divided pair is 1.6 micra.; single ones average a little longer.

No remedies for this disease are suggested.

## AGRICULTURAL SCIENCE NEWS.

The university of Wisconsin is to give a course of instruction in practical dairying this winter.

Dr. W. T. Wilson has been appointed to the professorship of veterinary science at the Royal agricultural college, Cirencester, Eng.

Mr. Henry L. Bolley, of Purdue university, issues in pamphlet form the thesis presented by him in June last to the faculty of Purdue university for the degree of M. S., entitled "The heterœcismal Pucciniæ."

One of the barns of the Mississippi agricultural and mechanical college, containing a large quantity of hay was destroyed by fire on Sept. 22. The loss in building, machinery, hay, ensilage, etc., will aggregate about $6,000.

On page 254 the statement is made that we gave in a previous issue of this journal Mr. C. L. Parsons' volumetric method for estimating fat in milk. This is in error. That given in the August number of this magazine is a gravimetric method.

The *Journal of comparative medicine and surgery*, commencing with Jan. 1, 1890, will be published monthly instead of quarterly and will be under the editorial charge of Dr. R. S. Huidekoper, dean of the veterinary college of the university of Pennsylvania.

Prof. W. O. Atwater, director of the office of experiment stations of the United States department of agriculture, and director of the Storrs school agricultural experiment station, has been elected director of the New Jersey station, at Rutgers' College, New Brunswick.

The report of the American pomological society, for the 1889 session, is a valuable and interesting document, and especially as related to the citrus fruits. It is a beautiful piece of typographical work, and is graced with a most excellent engraving of the president of the society, P. J. Buckmans of Augusta, Ga.

The September Kew bulletin of miscellaneous information discusses the following topics: Flower of Calligonum as an article of food in N. W. India; earliest notice of coca; buaze fibre; vegetable production, central China; vine cultivation in the Gironde; phylloxera in South Africa; erroneous report of phylloxera in Greece.

Prof. James, of the Ontario agricultural college, contributes a paper on "Ontario oats" which forms bulletin 45 of the agricultural college at Guelph. He principally gives the composition of 10 varieties of oats, and compares their average analyses with those of Kœnig, Brewer, Jenkins and Richardson. The average of James' analyses is closely identical with those analyzed by Kœnig. Bulletin 46 by Prof. Panton is on "chess" (Bronus secalinus).

According to *Science* (Oct. 4,'89) at a congress of planters, exporters and persons interested in sugar production, held at Samarang, Java, $90,000. was subscribed with which to secure a bacteriologist from Europe, to study the nemotode attacks on sugar cane, called the "sereh" disease. The malady became known about three years ago at Cheribon, and is now spreading rapidly and disastrously through the cane field of western and central Java.

Mr. Douglas A. Gilchrist has been elected to the lectureship in agriculture to the university college of North Wales. Prof. Gilchrist was a gold medalist in agriculture at the Glasgow and west of Scotland technical college, later won the Steven scholarship in agriculture at Edinburgh university, Scotland. He was also medalist in veterinary hygiene at the new veterinary college, Edinburgh. The appointment is for five years, with a salary of £250 per year.

The report of the botanist of the United States department of agriculture is upon grasses and weeds, with a paper by F. W. Anderson upon "the pastoral resources of Montana." The following are the grasses and weeds described: *Reimaria oligostachya*, *Paspalum vaginatum*, *P. distichum*, *Setaria viridis*, *Oplismenus setarius*, *Beckmannia erucæformis*, *Anthenantia rufa*, *Amphicarpum Purshii*, *Leersia Virginica*, *Poa andina*, *Agropyrum glaucum*, *Plantago Patagonica*, *Lygodesmia juncea* and *Solanum triflorum*.

From comparative analyses with manures, F. Martinotti concludes (*Zeit. f. Anal. Chem.*, xxviii, p. 415 ) that in the absence of nitrates the Kjeldahl method is preferable to the soda-lime. He considers the use of mercury, and in many cases potassium permanganate, unnecessary, and finds that in their absence the distillation is more regular. In the presence of nitrates he does not recommend the use of the Kjeldahl-Jodlbauer method, but prefers to first reduce the nitrate by heating with concentrated hydrochloric acid and ferrous chloride.

The royal society of science of Denmark has offered a prize of Kr. 600 for a chemial investigation as to the fatty acids present in butter-fat, each acid to be isolated and sufficiently identified. The relative amount of the different fatty acids, of which the investigation is expected to give information, should be given with the methods employed, as far as they are new or otherwise of interest, and especially is wanted the proportion between oleic acid and palmetic acid with its higher homologues. Papers, which may be written in Danish, Swedish, English, German, French or Latin, are to bear no name but a motto, and a sealed envelope with the same motto, enclosing the name, position and address of the author, must be sent with the paper, which should be sent before Oct. 31, 1890, to Dr. H. G. Zeuthen, secretary of the society.

## EXPERIMENT STATION ITEMS.

*Errata.* In the October number, on page 277, sixth line from the bottom, the words "*plaster land*," should read *land plaster*.

Bulletin No. 11 of the Arkansas station, reports upon varieties of strawberries and wheat and upon fertilizer tests on oats. Sixty-three varieties of strawberries are reported upon.

Bulletin 67 of the North Carolina station is entitled "practical stock feeding on scientific principles, together with its relations to chemistry." It is by the first assistant chemist, F. B. Dancy.

Bulletin 52 of the Michigan station reports certain fertilizer laws, and gives analyses for fertilizers, as performed by Dr. Kedzie. Bulletin 53 is upon spraying with arsenites, by Prof. A. J. Cook, an abstract of which we give elsewhere.

The September circular of the Mass. state experiment station contains analyses of commercial fertilizers and manurial substances sent in for examination. Also, analyses of commercial fertilizers collected during the past season, in the general markets.

Experiment station bulletin number two of the office of experiment stations of the United States department of agriculture is a useful digest of the annual reports of the agricultural experiment stations in the United States for 1888. This comprises part one; another part will be issued later.

Bulletin five of the central experimental farm of Ottawa, Canada, is upon the strawberry. It is well illustrated with 25 engravings of varieties and plants, describes over 80 varieties in a clear practical way, and should serve as a useful, brief handbook on strawberry culture and varieties, for Canada. For market purposes, Crescent, Captain Jack, Wilson and Manchester; for home use, Buback, Pearl, Hoverland, Crawford, Warfield, Jessie Monmouth, Ohio, Daisy, Gandy and Woodhouse are recommended as most satisfactory or most promising.

At a meeting of horticulturists of the several experiment stations, held at Columbus, Ohio, June 13 and 14, it was decided that stations ought not to buy new varieties; that uniform methods of notetaking were probably not practicable; that in reporting results to the public the stations should adhere to the forms provided by the office of experiment stations of the department of agriculture; that a guarantee should be given to originators that the stations should not distribute new varieties to the public; that stations should insist upon the privilege of furnishing new varieties to each other.

Bulletin 21 of the Kentucky station discusses wheat experiments and the grain louse. The wheat experiments were (1) test of varieties; (2) methods of seeding; (3) test of fertilizers. The best yielding varieties were German emperor and Egyptian. Canadian Finley and Hunter's white were among the best in appearance of grain. In tests of different methods of drilling, seed placed from one to two inches below the surface gave the best results. The tests with fertilizers gave results from which no conclusions are drawn, in view of the fact that the unfertilized land produced nearly as large a yield as the fertilized. The station entomologist gives some notes upon the grain louse (*siphonophora avenæ.*)

Bulletin three of volume two of the Ohio station discusses two subjects: (1) silos and ensilage, and (2) silage vs. field beets as food for milk production. The first article, on silos and ensilage, is largely practical in character. Bulletin five is upon experiments in wheat seeding, and a comparative test of varieties of wheat. In drilling in seed from five to seven pecks per acre are recommended. The time of seeding ranges from the last days of September and the first of October. The depth of seeding is largely to be governed by the soil. Mulching during the winter has not proven of practical benefit. On sterile soils, nitrogen and phosphoric acid must be in the fertilizer, with the former in larger proportion. On medium fertile soil, both nitrogen and phosphoric acid are necessary, while on rich soils no increase in crop was secured from fertilizers.

Dr. J. C. Arthur, botanist to the Indiana station, is the author of bulletin 28 of that institution, which is on the smut of wheat and oats, and while not presenting largely of special original investigations, records some practical observations, and furnishes in addition much useful and valuable data concerning *Tilletia fœtens*, B. and C., and *Ustilago segetum*. A specimen of wheat head affected by Tilletia accompanies this admirable bulletin. The author describes black smut and stinking smut or bunt. The bulletin principally relates to the latter disease. The following points are touched upon concerning bunt: amount of loss; description of the fungus; early opinions; external characters; name; growth and reproduction; attack and spread of the disease; natural check to increase; nature of the injury, and remedies and precautions. Black smut (*Ustilago segetum*) is described and illustrated.

NOTICE. Most unfortunately the proofs and manuscript of all the matter in this number, excepting the leading contribution, were lost in the mails. They were regularly received at Knoxville, but as the editor was absent in Washington, were forwarded to him there, were not received nor can any trace of them be found. Although the pages have been carefully corrected by the printer, they have not had editorial correction. We trust that our readers will consequently take into consideration the circumstances, if errors occur.

On Dec. 29, 1888, the governor of Georgia approved an act of the general assembly providing for the appointment of a board of directors and the permanent location and organization of the Georgia experiment station. As directors, the governor appointed one practical farmer from each of the ten districts of the state, and Dr. H. C. White, chemist to the university of Georgia. At a meeting of the board on May 7, '89, the Bates farm at Griffin, Spalding county, was selected as suited to the needs for a station and farm. On May 8, on the 34th ballot of the board of directors, Mr. J. M. Kimbrough was elected agriculturist and dairyman at a salary of $1,500. per year. On August 2, Mr. Gustave Speth was elected horticulturist, and Mr. R. J. Redding, director. These officers are elected for one year. This station is a successor to the one at Athens, Ga., of which Dr. W. L. Jones is at present director. In the absence of proper laboratory buildings at Griffin, for the sum of $5,500. the university of Georgia has agreed to carry on the scientific experiments for one year, beginning July 1, 1889. The station farm comprises 130 acres of gently rolling red and gray soil, underlaid by a strong red clay. It is a typical middle Georgia farm.

The following is the report of the committee on nomenclature appointed by the station horticulturists in their meeting held at Columbus, Ohio, in June, 1889. Rules: (1) The name of a variety should consist of a single word, or at most, of two words. A phrase, descriptive or otherwise, is never allowable; as Pride of Italy, King of mammoths, Earliest of all. (2) The name should not be superlative or bombastic. In particular all such epithets as new, large, giant, fine, selected, improved and the like should be omitted. If the grower or dealer has a superior stock of a variety, the fact should be stated in the description immediately after the name, rather than as a part of the name itself; as "trophy, selected stock." (3) If a grower or dealer has procured a new select strain of a well known variety, it shall be legitimate for him to use his own name, in connection with the established name of the variety; as Smith's Winningstadt, Jones' cardinal. (4) When personal names are given to varieties, titles should be omitted; as major, general, queen. (5) The term *hybrid* should not be used, except in those rare instances in which the variety is known to be of hybrid origin. (6) The originator has the prior right to name the variety; but the oldest name which conforms to these rules should be adopted. (7) This committee reserve the right, in their own publications, to revise objectionable names in conformity with these rules.

The last bulletin from the Nebraska station, for June, 1889, is numbers 7, 8, 9 and 10 combined into one, under the title "Original investigations of cattle diseases in Nebraska 1886–1889." This is by Dr. F. S. Billings, and in typography is a good piece of work. But once more Dr. Billings issues a bulletin remarkable for its abusive personalities, the most remarkable bulletin without question ever issued by an American experiment station, if not in the world. Dr. Billings may be a most eminent scientist (and we believe that he has done much good through his investigations) and we would say nothing to detract from the value of the work he has done, but as an officer of an American experiment station, if he wishes to have his work retain the approval of other scientists, he must present his report as a gentleman, rather than a boor. The questionable habit of mud slinging does not especially inspire the outsider in the belief that there is no mud on the thrower. The public are aware that Messrs. Salmon and Billings are at variance regarding certain lines of veterinary research, and that the latter has not hesitated through public prints to designate the work of the former as false, stupid, etc. Further, it is known that a government commission was appointed to sit in judgment, as it were, upon the work of the parties referred to, and that this commission presented to the public a most unsatisfactory report. And so, when Dr. Billings cannot find in a commission of doctors the support he craves, how can he suppose that the laymen can become convinced in the face of such language as we quote further on, when emanating from his pen? This bulletin discusses (1) the southern cattle plague and yellow fever; (2) the corn stalk disease; (3) the so-called hydrophobia of cattle; (4) contagious inflammation of the cornea in cattle and (5) a singular disease of the sexual organs in cows. To illustrate the exceptional style of writing of Dr. Billings, we quote the following in which the writer refers to certain points in his contemporary's work; we quote: "More illogical and absurd contradictions than the above could not possibly emanate from the merest novice upon disease." "It is incomprehensible to me how a person of Detmers' cleverness could have made such an assertion." . . . "With these remarks we may drop Detmers' saliva theory." "Wrong as usual!" "Hence the germ of the southern cattle plague has been discovered, and I think that I may be pardoned the egotism of claiming this to be the first occasion in the history of American medicine that not only one but several germ diseases of animal life has been traced out, and their origin placed upon an impregnable scientific basis." "I am perfectly well aware of the extreme relish with which my estimable conf[illegible] rere in the world would point out any serious error in the work of so severe a polemist as myself, but I am equally well aware of the character of the few abilities I may possess, and of the painful exactness used when it is absolutely necessary. Some may think we are bold; but when caution is warranted by the evidence, I can use as much of it as anyone, as will be seen in my treatment of some diseases later on in this report." "Whew!" "That is what I call straining at a gnat and swallowing at a whole camel." "I trow not! Had I such want of faith in my own judgment—had I so lacked in common-sense—I should be unworthy of the position I occupy or reputation I enjoy." And we would close these interesting quotations with the following words of the author: "Such language as that can only emanate from one most seriously wanting in clinical and necroscopical experience, but above all in pathological acumen and rational common sense. I am perfectly well aware that the whole ultra-bacteriological school will raise a hurricane of indignation about my ears, but nevertheless I do say that such language as that is absolutely insane under certain circumstances."

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# THE SOILING SYSTEM FOR MILCH COWS.

BY H. P. ARMSBY, WM. FREAR, H. J. PATTERSON, G. L. HOLTER AND W. H. CALDWELL.

*(Concluded from November number.)*

## Experiment at the agricultural experiment station of the university of Wisconsin.

During the summer of 1887, the writer carried out an experiment very similar to the one just described, at the above institution, with which he was then connected. In this experiment the grass used was considerably more mature, being cut when some six or eight inches high. No determinations were made of the digestibility of the grass, but, on the other hand, the amount of butter produced from the milk of the cow was determined, and its quality passed upon by an expert. An unfortunate mistake diminished somewhat the value of the experiment. It was the intention to make grass the sole feed of the cow, but by a misunderstanding of orders the cow was fed wheat bran by measure like the rest of the herd. When the mistake was discovered, about the end of the first period, the herdsman was directed to measure out the customary amount of bran and place it on the scales. This was repeated three times, and, the three weighings agreeing closely, their average was taken to represent the amount of bran which had been fed, and throughout the rest of the experiment this amount was weighed out daily to the cow. The amount of bran fed per day was 5.5 lbs. The cow used in the experiment was a grade Jersey, which had previously been used in the experiments on milk production described in the report of the Wisconsin station for 1887. She was kept in the barn during the day, but was allowed to run in the yard during the night. She could not have found there, however, any material amount of food. The feeding trial began May 26th. The actual experiment began June 2d, the green grass period ending June 15th, and the dried grass period June 29th. The experiment was conducted substantially like the one just described. During the green grass period a quantity of green grass was cut each morning, more than sufficient for the day's feeding. The grass was mixed as well as possible while being loaded upon a cart, was then drawn to the barn, and 70 lbs. of it weighed out for the day's feeding. About half of this amount was fed at once, while the other half was set aside in a covered basket for the night's feed. A second portion of 70 lbs. was weighed out at the same time, and carefully dried on large sheets in the sun. When dry it was put in cloth bags, and labeled with the date of its cutting. Finally a sample of the green grass was taken for analysis, about a peck taken from different portions of the mass being cut fine in a large meat chopper, and a portion of 200 grams of the chopped grass weighed out for air-drying. This course of feeding was continued for two weeks. Then the dried grass was fed in the same order in which it was cut, as described in the previous experiment. It was intended to conclude the experiment with a second period of green grass feeding, but a season of severe and continued drought came on, and rendered the grass so woody and inferior in quality that the third period had to be abandoned.

**Composition of grass**—The samples of grass taken for analysis, as described above, were dried in a drying closet, then allowed to stand several days at ordinary temperature, and finally the 14 samples were united to form a single analysis sample. Details as to the air-drying of the individual samples will be found in the appendix. The following was the composition of the grass as shown by the analysis of the united samples:

COMPOSITION OF GRASS.

| | As sampled. | Air dry. | Water free. |
|---|---|---|---|
| Water | 76.28 | 9.77 | ...... |
| Ash | 1.63 | 6.26 | 6.94 |
| Protein | 3.43 | 13.06 | 14.47 |
| Crude fiber | 6.93 | 26.34 | 29.20 |
| Nitrogen-free extract | 10.96 | 41.64 | 46.14 |
| Fat | 0.77 | 2.93 | 3.25 |

The composition of the wheat bran mentioned above was as follows:

| | |
|---|---|
| Water | 11.97 |
| Ash | 3.99 |
| Protein | 19.75 |
| Crude fibre | 5.45 |
| Nitrogen-free extract | 54.07 |
| Fat | 4.77 |

**Nutritive effect.**—Live weight:—The weight of the animal was taken daily. The individual weighings are tabulated in the appendix. The averages of the daily weighings for each half of the two periods were as follows:

Period I. Green grass.
First half....885 lbs.
Second half....908 "

Period II. Dried grass.
First half....929 lbs.
Second half....937 "

There was a steady increase in the weight of the animal, slightly less rapid in the second period than in the first, but with not enough difference between the two to indicate anything like deficient nutrition.

**Quality of milk.**—The morning's milking, after being weighed and thoroughly mixed, was sampled for analysis, about half a pint being taken. This was set aside in a cool place until evening, when the evening's milk was sampled in the same way, the same volume of milk being taken. The mixed samples of morning's and night's milk constituted the analysis sample. Strictly speaking, each of these samples should have been an aliquot portion of the total weight of milk, but the amount produced at the two milkings was so nearly equal that the error introduced by taking equal volumesof the two milkings must have been extremely insignificant. The same is true of all the samples of milk taken in this whole series of experiments. The results of the daily analyses are given in the appendix. The averages are as follows :

AVERAGE PERCENTAGE COMPOSITION OF MILK.

| | Total solids. | Fat. |
|---|---|---|
| Period I. Green grass. | | |
| 1st half | 14.13 | 5.15 |
| 2d " | 14.62 | 5.64 |
| Whole | 14.36 | 5.40 |
| Period II. Dried grass. | | |
| 1st half | 14.15 | 5.79 |
| 2d " | 14.36 | 5.44 |
| Whole | 14.26 | 5.61 |

The figures vary somewhat, but so irregularly that they do not indicate any distinct effect of the variations in food on the composition of the milk. The average of the second period is nearly or quite as good as that of the first.

**Quantity of milk.**—The average yield of milk for each half of each period is shown below. The daily yields will be found in the appendix.

AVERAGE DAILY YIELD. GRAMS.

| | Milk. | Total solids. | Fat. |
|---|---|---|---|
| Period I. Green grass. | | | |
| 1st half | 7854 | 1110 | 405 |
| 2d " | 7549 | 1104 | 426 |
| Whole | 7702 | 1107 | 416 |
| Period II. Dried grass. | | | |
| 1st half | 7791 | 1102 | 451 |
| 2d " | 8370 | 1202 | 455 |
| Whole | 8081 | 1152 | 453 |

There was a slight falling off in the yield as between the first and second halves of the first period, except in the case of the fat. With these exceptions, there was an increase of yield as the experiment progressed. It is remarkable that this experiment, like the one previously described, seems to show a slight gain as the result of drying, but even though the two experiments concur in this respect, I believe we are warranted in assuming this slight gain to be accidental, and not due to the feeding. It is certainly difficult to conceive how drying the fodder should improve its quality. Both experiments coincide however, in failing to show any loss as the result of drying. If there were any such marked difference between green and dry fodder, as is sometimes claimed, it seems hardly possible that it should have failed to show itself in two experiments conducted on the whole as carefully as these.

**Yield of butter.**—In this experiment each milking was, after being sampled, placed in a small Cooley can, and the cream produced, after proper ripening, was churned every three days. The butter was salted as usual, one ounce to the pound, but not colored. After weighing, a sample of about a pound was packed in a tin box, which was placed inside a wooden box, surrounded by grass, and shipped at once by express to a butter dealer in Chicago for rating according to the established scale of points. The following table shows the average yield of butter and gives also the weight of pure fat contained in the butter. By thus taking the amount of fat in the butter as the basis of comparison, we may eliminate any errors due to the varying amounts of water, salt, casein, etc., contained in the commercial butter. For details as to weight and composition of the separate samples of butter, see appendix.

AVERAGE DAILY YIELD OF BUTTER. GRAMS.

| | Fresh butter. | Butter solids. | Butter fat. |
|---|---|---|---|
| Period I. Green grass. | | | |
| First six days | 407 | 350 | 328 |
| Last seven days | 482 | 409 | 388 |
| Whole | 447 | 382 | 360 |
| Period II. Dried grass. | | | |
| First six days | 425 | 372 | 357 |
| Last nine days | 447 | 387 | 371 |
| Whole | 438 | 381 | 365 |

The yield of butter is practically the same in the two periods, or, if we make allowance for the slight variations in composition by making the yield of butter fat the basis of comparison, shows a slight gain in the second period. It should be noted, however, that this slight gain in the second period is considerably less than corresponds to the increased amount of fat in the milk produced, as shown by the previous table.

**Churnability of milk fat.***—The fact just mentioned leads naturally to a consideration of the relation between the total fat contained in the milk and the amount of butter which was made from it. Not all the fat of the milk can be converted into butter. A small portion of it in any case remains in the skimmilk, and another, usually somewhat larger, portion in the buttermilk. It appears from numerous experiments that the food of the animal may influence to a considerable extent the proportion of the total fat of the milk, which is recovered in the butter by the methods of the ordinary dairy. It is plain, then, that if any particular food or method of feeding has the effect of causing the milk to churn better, or, in other words, enables us to get out of the milk a larger proportion of the fat which it contains, that food or that method of feeding may be of special value to the butter-maker even though it does not produce any greater total amount of fat in the milk. The subject of the influence of feed on the churnability of milk has been comparatively little studied, but a few recent experiments go to show that the use of green, succulent food may result in a more complete separation of the butter from the milk. The following brief summary of the results of experiments upon this point is substantially that given by Woll in the fifth report of the Wisconsin agricultural experiment station, pages 53 to 55.

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*Since this paragraph was written Myers, in experiments at the West Virginia agricultural experiment station, has shown that by a suitable manipulation of the milk, aided by the centrifugal, the conception of "churnability" may be entirely eliminated. In other words, the "churna-

Alvord[1] gives the following results of trials made at Houghton farm. The first table below shows the total amount of fat in the milk, the amount of fat in the butter obtained by churning the same milk, and finally the percentage of the total amount of fat in the milk which was recovered by the churn. The results show the average product of the same lot of cows fed first on hay and grain in April, second on ensilage and grain in March, and third on good pasturage in May. The second table gives similar data for a single cow "selected for the apparent uniformity of her product, and of her health, appetite and general condition."

In the table as given, the amount of butter fat obtained has been substituted for that of the butter obtained as given in the original paper, it being assumed that the butter contained 85 per cent. of fat. While it is not likely that this was exactly true, it is hardly possible that the variations in the composition of the butter should account for the differences observed.

| Found in 100 lbs. of milk. | Fed hay and grain in April. | Fed corn ensilage and grain in Mch. | On good pasturage alone in May. |
|---|---|---|---|
| Actual fat in milk | 5.12 lbs. | 4.37 lbs. | 4.13 lbs. |
| Butter fat obtained | 4.21 " | 3.71 " | 3.58 " |
| Per cent. of fat churned out | 82.17 " | 84.80 " | 86.64 " |

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bility" of milk expresses simply the degree of perfection to which our mechanical appliances have advanced.

[1] Proceedings of soc. for prom. of agrl. sci., 1883-84, p. 21.

TRIAL WITH SINGLE COW.

| Found in 100 lbs. of milk. | Fed hay and grain in March. | Fed corn ensilage and grain in March. | Fed corn ensilage alone in April. | On good pasturage alone in May. |
|---|---|---|---|---|
| Actual fat in milk | 4.76 lbs. | 4.42 lbs. | 3.93 lbs. | 4.64 lbs. |
| Butter fat obtained | 3.60 " | 3.73 " | 3 36 " | 4.04 " |
| Per cent. of fat churned out | 75.53 " | 84.43 " | 85.43 " | 87.02 " |

Alvord's conclusion from the above results is that "the greater the proportion of succulent food, the more completely the churn will do its work."

Experiments by Sturtevant[1], in which the total fat of the milk was compared with that obtained by churning on a small scale, show very considerable variations in the churnability of the milk on different feeds, but the feeding periods were too short to allow any very definite conclusions to be drawn as to the exact effect of the feed in this respect. It is worthy of note, however, that with one exception the ensilage period gave the highest churnability.

In experiments upon the comparative value of corn fodder and ensilage, Woll[2] found that during the period in which ensilage was fed, the percentage of fat obtained in the butter was greater by 12.60 than the average of the two periods in which corn fodder was fed. His results were as follows;

| Feed. | Butter fat. | Milk fat. | Churned out. |
|---|---|---|---|
| Corn fodder and grain | 11.59 lbs. | 13.12 lbs. | 88 35 per cent. |
| Ensilage and grain | 11.05 " | 11.61 " | 95.15 " |
| Corn fodder and grain | 9.50 " | 12.38 " | 76.74 " |

In our own experiment the proportion of the total fat which was recovered in the butter was as follows:

| | | |
|---|---|---|
| Period I.—First half | | 80.95 |
| | Second half | 91.18 |
| | Whole | 86.64 |
| Period II.—First half | | 79.23 |
| | Second half | 81.45 |
| | Whole | 80.65 |

Here we have a difference of six per cent. in the churnability of the milk, or if we compare the second halves of the two periods, a difference of nearly 10 per cent., in favor of the green grass.

It would seem from these results to be highly probable that green succulent food does improve the churning qualities of milk, and that if, in the experiments described above, butter had been made from the milk, there would have been a gain in the first period as compared with the second.

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[1] 3d Report New York agricultural experiment station, p. 95.

[2] 5th Rep. Wis. exp't. station, p. 52.

**Quality of butter.**—As noted above, samples of the butter from each churning were sent to a Chicago dealer for rating. The samples sent him were designated by number only, and he had no knowledge of the nature of the experiment in progress. The following is his letter, enclosing his report on the samples:

"Please find enclosed score of the samples of the butter sent me. You will see that I have made the score 50 points. The flavor, I presume, is what you most wanted. The examination made yesterday was made without any reference to the former score, and, of course, I have allowed a little in flavor for the stock being old.

"I was quite surprised to find numbers four, five and six very rank in flavor. The number one was quite oily. The others were about as ordinary butter is after being held. This butter was put on a shelf on the side of my ice-box in my refrigerator, and I do not think the temperature varies much from 55, and I was surprised that the lots which I have named should get so badly off in flavor. I had my butter man make the score at the same time, without knowing what the other man put down, and we ran very close on points, and I have averaged them so I think they will be about right. There was none of it as high in flavor as some of the fine creameries which we receive, but I suppose it could not be done in making such small lots. Yours truly,

"A. H. BARBER."

The results on the fresh butter were as follows:

GREEN GRASS PERIOD.

| No. of Sample | Milk of | Churned. | Flavor. 30 | Grain. 10 | Color. 5 | Salt. 5 | Total. 50 |
|---|---|---|---|---|---|---|---|
| 1 | June 3,4 and 5.... | June 6 | 20 | 10 | 4 | 5 | 39 |
| 2 | " 6, 7 " 8... | " 9 | 12 | 8 | 5 | 4 | 29 |
| 3 | " 9 10 " 11.. | " 14 | 22 | 9 | 4½ | 4½ | 40 |
| 4 | " 12,13,14.15 | " 17 | 20 | 8 | 4½ | 4½ | 37 |
| | | Average | 18.5 | 8.75 | 4.5 | 4.5 | 36.25 |
| DRIED GRASS PERIOD. | | | | | | | |
| 5 | June 16, 17, 18... | June 20 | 18 | 7 | 4 | 3 | 32 |
| 6 | " 19, 20, 21... | " 23 | 14 | 8 | 3½ | 4 | 29½ |
| 7 | " 22, 23, 24... | " 27 | 16 | 10 | 5 | 4 | 35 |
| 8 | " 25, 26, 27... | " 30 | 21 | 10 | 5 | 5 | 41 |
| 9 | " 28, 29, 30... | July 2 | 20 | 10 | 3½ | 4 | 37½ |
| | | Average | 17.8 | 9 | 4.2 | 4 | 35.0 |

On August 4th a second examination of the samples was made, they having meanwhile been kept in the ice-box, with the following results:

GREEN GRASS PERIOD.

| No. of Sample | Milk of. | Churned. | Flavor. | Grain. | Color. | Salt. | Total. |
|---|---|---|---|---|---|---|---|
| 1 | June 3, 4 and 5..... | June 6 | 10 | 10 | 5 | 5 | 30.0 |
| 2 | " 6, 7, 8 ......... | " 9 | 15 | 10 | 5 | 4 | 33.5 |
| 3 | " 9, 10, 11 ...... | " 14 | 8 | 10 | 4½ | 4 | 27.0 |
| 4 | " 12, 13, 14, 15 | " 17 | 5 | 10 | 5 | 5 | 25.0 |
|  |  | Average | 9.5 | 10 | 4.9 | 4.5 | 28.9 |

DRIED GRASS PERIOD.

|  |  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|---|
| 5 | June 16, 17, 18...... | June 20 | 5 | 7 | 4 | 3 | 19.0 |
| 6 | " 19, 20, 21 ..... | " 23 | 5 | 8 | 4 | 4 | 21.0 |
| 7 | " 22, 23, 24 ..... | " 27 | 10 | 10 | 5 | 4 | 29.0 |
| 8 | " 25, 26, 27 ..... | " 30 | 12 | 10 | 5 | 4½ | 31.5 |
| 9 | " 28, 29, 30 ..... | July 2 | 16 | 10 | 4 | 4 | 34.0 |
|  |  | Average | 9.6 | 9.0 | 4.4 | 3.9 | 26.9 |

Nos. 4, 5 and 6 rancid; No. 1 oily.

It will be seen that the differences between the classes of samples were comparatively small, and on the average showed that the chief difference between the two was in the flavor, though even here the difference does not amount to a whole point. If we allow any significance to this slight difference, the general result of the comparison is that the butter from the green grass was slightly better at first than that from the dried grass, but did not keep quite as well. It appears doubtful, however, if these small differences have any significance whatever. It will be observed that the quality of none of the samples was very high. This was probably due, as Mr. Barber's letter suggests, to the fact that the butter was made in small lots, and therefore not under the most favorable conditions, and to the further fact that the single cow used had been in milk about seven months.

**Conclusion.**—The experiments described above, taken in connection with what is already known on the subject, lead to the conclusion that the simple drying of grass, without loss, does not diminish either its digestibility or its nutritive value, as a food for milch cows, with the single exception that dried food seems to influence unfavorably the churning qualities of the milk.

**Comparison with feeding standard.**—It is of interest to compare the amount of food consumed in our experiment with the feeding standard for milch cows as given by Wolff. Taking the average of the two periods as representing most fairly the amount of digestible matter consumed, we have the following comparison:

RATIONS PER DAY AND 1,000 POUNDS LIVE WEIGHT.

| | Our experiment. | Feeding standard |
|---|---|---|
| Total dry matter | 18 09 | ...... |
| Digestible protein | 2 73 | 2.50 |
| " carbohydrates | 13.30 | 12 50 |
| " fat | 0.64 | 0.40 |
| Total digestible organic matter | 16.67 | 15.40 |
| Nutritive ratio | 1:5 6 | 1:5.4 |

Our ration was somewhat heavier than that called for the standard, but the proportions of the several ingredients were very nearly the same.

## Yield and nutritive value of soiling crops.

BY H. P. ARMSBY AND W. H. CALDWELL.

As before stated, the object of this part of the investigation was to observe the system as actually practiced here. The information thus gained may perhaps be made the basis for future investigations and improvements in the system. The soiling crops used were rye, clover and corn. The interval between clover and corn has been hitherto filled up by the use of grass cut along the sides of the drives, and in various other places, but this was not made the subject of experiment.

The plan of the experiments originated with the director, and the discussion of the results is also his work. The details of the experiment were cared for entirely by Mr. Caldwell, while the analytical work involved was performed by the station's assistant chemists, Messrs. Patterson, Holter and Sweetser.

The crops mentioned above were grown on specially rich ground which is heavily manured in order to obtain the greatest possible yield, and to diminish the relative cost of cutting and hauling. The rye is sown at successive intervals from early September to the last of October, at the rate of four bushels per acre, upon ground which has been deeply plowed, thoroughly cultivated with a spring harrow, and before plowing covered with as much well rotted yard manure as can be plowed under. These sowings yield crops developing at closely succeeding periods during the following May and early June. The clover crop follows the rye in our practice, two qts. of timothy seed per acre being sown with the rye, and about six qts. of clover seed being sown early the following spring. The crop being first year's growth, the timothy constitutes a very small proportion of the yield. The corn follows either rye or clover. The land is given about 20 two-horse loads of manure per acre, and, after plowing, is thoroughly harrowed, rolled, and then seeded with four bushels of dent corn per acre, sown in drills three feet apart. Feeding is begun when the stalk attains a height of four or five feet, and it is fed up as rapidly as possible after that time.

## COMPOSITION OF SOILING CROPS.

No analyses of the soiling crops were made in connection with this experiment, but a series of digestion experiments upon them was in progress at the same time, under direction of Dr. William Frear, the results of which will be reported later. In the computations connected with these experiments we have used the results as to composition and digestibility which were obtained in these digestion experiments and which are summarized below.

### PERCENTAGE COMPOSITION OF SOILING CROPS—GREEN.

| | Water. | Ash. | Albuminoids. | Non-albuminoids. | Crude fiber. | N. fr. extract. | Fat. |
|---|---|---|---|---|---|---|---|
| Rye, May 21–27..... | 85.13 | 1.38 | 1.13 | 1.58 | 3.99 | 5.96 | 0.83 |
| " " 28–Jun.1 | 83.53 | 1.27 | 1.21 | 1.06 | 5.51 | 6.73 | 0.69 |
| Clover, Jun. 3–10... | 85.66 | 2.14 | 3.08 | 0.13 | 2.71 | 5.49 | 9.79 |
| " " 11–15... | 83.62 | 2.53 | 2.74 | 0.90 | 3.44 | 5.95 | 0.82 |
| Corn, Aug. 9–18... | 90.26 | 1.32 | 1.52 | 0.28 | 2.50 | 3.68 | 0.44 |
| " " 19–23... | 89.81 | 1.12 | 1.40 | 0.24 | 2.92 | 4.15 | 0.36 |

### PERCENTAGE COMPOSITION OF DRY MATTER OF SOILING CROPS.

| | Ash. | Albuminoids. | Non-albuminoids. | Crude fiber. | N fr. extract. | Fat. |
|---|---|---|---|---|---|---|
| Rye, May 21–27..... | 9.28 | 7.58 | 10.64 | 26.81 | 40.12 | 5.57 |
| " " 28–Jun.1 | 7.67 | 7.35 | 6.42 | 33.47 | 40.88 | 4.21 |
| Clover, June 3–10... | 14.92 | 21.49 | 0.89 | 18.89 | 38.27 | 5.54 |
| " " 11–15... | 15.46 | 18.33 | 3.87 | 20.97 | 36.36 | 5.01 |
| Corn, Aug. 9–18..... | 13.60 | 15.55 | 2.88 | 25.61 | 37.89 | 4.47 |
| " " 19–23..... | 10.97 | 13.81 | 2.31 | 28.66 | 40.75 | 3.50 |

### DIGESTIBILITY OF SOILING CROPS.

| | Total dry matter. | Fat | Fiber. | Nitrogen fr. extr't. | N×6.25. | Albuminoids. | Ash. | Nutritive ratio. |
|---|---|---|---|---|---|---|---|---|
| Rye ...... | 73.6 | 74.2 | 79.6 | 70.6 | 79.1 | 56.1 | 55.5 | 1:4.8 |
| Clover... | 66.1 | 64.5 | 52.6 | 77.6 | 67.0 | 63.3 | 55.0 | 1:3.2 |
| Corn ..... | 68.7 | 40.0 | 74.7 | 70.8 | 78.1 | 74.3 | 60.7 | 1:3.7 |

Samples of the hay and grain used in the experiment were taken at different times for analysis. The results for hay as given below have been corrected. The analyses as reported gave water 8.88 and 10.01 per cent. respectively. This arises from the fact that by a misunderstanding the samples were not weighed immediately upon receipt at the laboratory, but were allowed to stand for a few days before being analyzed. As will be seen below, the analyses have been recalculated upon the basis of 14 per cent. of water. The figures for water in the samples of chop also seem abnormally low, but it was on the whole thought best not to undertake any correction in this case.

| | Water | Ash. | Albuminoids. | Non-albuminoids. | Crude fiber. | N-fr. ext | Fat. |
|---|---|---|---|---|---|---|---|
| Hay—preliminary feeding | 14.00 | 6.01 | 7.75 | 1.08 | 26.53 | 41.24 | 3.39 |
| Bran—period 1 | 10.70 | 13.25 | 15.69 | 3.37 | 3.54 | 49.74 | 3.71 |
| Chop— " 1 | 9.50 | 9.94 | 9.63 | 1.35 | 3.12 | 61.65 | 4.81 |
| Bran— " 3 | 11.19 | 9.96 | 13.31 | 2.62 | 6.07 | 53.41 | 3.44 |
| Chop— " 3 | 10.45 | 7.80 | 10.06 | 0.98 | 3.48 | 61.59 | 5.64 |
| Hay—Period 3 | 14.00 | 5.55 | 10.13 | 2.09 | 23.75 | 41.42 | 3.06 |

In the computation of the amounts of digestible matter eaten, the following coefficients of digestibility were assumed for the above fodders:

| | Protein (N× 6.25) | Non-albuminoids. | Crude fiber. | Nitrogen-free extract. | Fat. |
|---|---|---|---|---|---|
| Oats | 77 | 100 | 17 | 74 | 82 |
| Maize | 79 | 100 | 62 | 91 | 85 |
| Chop (average of above) | 78 | 100 | 40 | 83 | 84 |
| Bran | 78 | 100 | 33 | 77 | 69 |
| Hay | 57 | 100 | 57 | 62 | 48 |

**Yield per acre.**—The soiling crops were cut twice per day, and the area cut was measured once in from one to four or five days, except in the case of the corn, of which only two measurements were taken, one of the area cut during the first four days of the feeding and the other covering the remainder of the period. The soiling rye was from two different plots, the soil of the second being considerably the richer. The yield in pounds per acre at the several dates is shown in the table below:

YIELD OF THE SOILING CROPS.

| *Rye* | Lbs. per acre. |
|---|---|
| May 15-17 | 15,680 |
| " 18 | 11,200 |
| " 19 | 12,230 |
| " 20-21 | 17,320 |
| " 22 | 9,541 |
| Average of first plot | 13,670 |
| May 23 | 13,850 |
| " 24-25 | 18,440 |
| " 26-27 | 15,450 |
| " 28-31 | 18,300 |
| June 1-4 | 25,980 |
| Average of second plot | 18,660 |
| Average of all | 15,890 |

| *Clover.* | Lbs. per acre. |
|---|---|
| June 4 8 | 23.680 |
| " 9 | 31,280 |
| " 10-12 | 28,010 |
| " 13,16 | 28.110 |
| Average | 26,650 |
| *Corn.* | |
| July 24 27 | 23.420 |
| " 28-Aug. 15 | 16,900 |
| Average | 17,890 |

Taking the average results per acre as the basis of computation, and the average of the two analyses of each crop given above to represent the average composition of that crop, we find the yield per acre of the several ingredients of these crops to have been as follows :

YIELD PER ACRE OF INGREDIENTS OF SOILING CROPS. LBS.

| | | | | | | | | Digestible. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total dry matter. | Ash. | Albuminoids. | Non-albuminoids. | Crude fiber. | N-fr. extr't. | Fat. | Albuminoids | Non-albuminoids*. | Carbhydrates. | Fat. |
| Rye...... | 2.491 | 211 | 189 | 209 | 751 | 1,009 | 122 | 106 | 209 | 1,310 | 90 |
| Clover... | 4.094 | 622 | 816 | 95 | 816 | 1,528 | 216 | 515 | 96 | 1.614 | 139 |
| Corn..... | 1,782 | 219 | 262 | 46 | 484 | 700 | 71 | 195 | 46 | 857 | 28 |

**Animals.**—Seven cows were used for this experiment. As has been already noted, they were only very ordinary milkers so that they are far from showing the best results that could be obtained with the soiling system. The animals were not weighed daily, but the regular monthly weighings along with the rest of the stock gave the following as the average live weight per head :

| | |
|---|---|
| May 1st | 808 lbs. |
| July 2d | 841 " |
| August 1st | 876 " |
| Sept. 1st | 881 " |

In the last period—soiling corn—one of the cows, having gone dry since the close of the clover period, was removed from the experiment and another one substituted ; consequently the last two periods in the above table are not exactly comparable with the first two.

**Feeding.**—For the first week of the experiment, beginning May 8th, the cows received as nearly as possible the same feed that they had been having up to that time, consisting of hay, bran and chop (about equal parts of corn and oats ground together.) The first feed of the rye was given on the afternoon of May 15th, and thereafter they received about half their total fodder in the form of soiling, the remainder consisting of hay and grain as before. The grain and hay were weighed out in advance in sufficient quantity to last for a number of days, and were fed to the cows in accordance with the judgment of the herdsman, he being instructed to feed as nearly as possible as he had been in the habit of doing in previous years. No attempt was made to ascertain the amount eaten by each individual cow. The amount of soiling fed was, of course, weighed, twice daily immediately after cutting. The following table shows the average amounts of the several fodders actually eaten per day and head. The amount of soiling eaten varied not inconsiderably from day to-day, as the figures given in the appendix show. The last portions of hay and grain weighed out for the rye period were more than sufficient to complete that period, and the residues were not weighed but were simply carried over to the clover period, consequently the amounts of hay and grain eaten, as given in the table, are the average of these two periods and may have varied somewhat in the single periods, although probably not very much.

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*Assumed to be wholly digestible.

EATEN PER DAY AND HEAD. LBS.

| | Chop. | Bran. | Hay. | Soiling. |
|---|---|---|---|---|
| Preliminary—May 8-15 | 2.07 | 1.97 | 18.47 | 0 |
| Rye period " 16-June 4 | 2.64 | 2.40 | 5.74 | 66.19 |
| Clover period—June 14-16 | | | | 69.52 |
| Corn period—July24-Aug. 15 | 2.57 | 1.67 | 5.56 | 83 09 |

The composition and digestibility of the soiling crops and other fodders has been already given. On the basis of these figures we may calculate the composition of the daily rations as follows:

RATIONS EATEN. POUNDS PER HEAD.

| | Total dry matter. | Digestible. | | | |
|---|---|---|---|---|---|
| | | Albuminoids. | Non-albuminoids. | Carbhydrates. | Fat. |
| Preliminary feeding. | | | | | |
| 2.07 lbs. Chop | 1.86 | 0.16 | 0.02 | 1.09 | 0.09 |
| 1.97 " Bran | 1.75 | 0.21 | 0.06 | 0.81 | 0.05 |
| 18.47 " Hay | 15 89 | 0.81 | 0.30 | 7.38 | 0.29 |
| | 19 50 | 1.18 | 0.38 | 9 28 | 0.43 |
| Period I. | | | | | |
| 2.64 lbs. Chop | 2.38 | 0.20 | 0.03 | 1.38 | 0.12 |
| 2.40 " Bran | 2.14 | 0.25 | 0.08 | 0.99 | 0.06 |
| 5.74 " Hay | 4.93 | 0.25 | 0.09 | 2.29 | 0 09 |
| 66.19 " Green rye | 10.38 | 0.44 | 0.87 | 5 46 | 0.38 |
| | 19.83 | 1.14 | 1.07 | 10.12 | 0.65 |
| Period II. | | | | | |
| 2.64 lbs. Chop | 2.38 | 0.20 | 0 03 | 1.39 | 0.12 |
| 2.40 " Bran | 2.14 | 0.25 | 0 07 | 0.99 | 0.06 |
| 5.74 " Hay | 4.93 | 0 25 | 0.09 | 2 29 | 0.09 |
| 69.52 " Green clover | 10.68 | 1.34 | 0.26 | 4 21 | 0.36 |
| | 20.13 | 2.04 | 0.45 | 8.88 | 0.63 |
| Period III. | | | | | |
| 2.57 lbs. Chop | 2.32 | 0.19 | 0.03 | 1.35 | 0.11 |
| 1.67 " Bran | 1.49 | 0.18 | 0.05 | 0.69 | 0.04 |
| 5.56 " Hay | 4.78 | 0.24 | 0.09 | 2.22 | 0.09 |
| 83.09 " Green corn | 8.28 | 0.90 | 0.22 | 3.98 | 0.20 |
| | 16.87 | 1.51 | 0.39 | 8.24 | 0.44 |

For convenience of comparison, the figures of the above table have been condensed into the shorter table which follows, showing the amount of total dry matter, and of its several digestible ingredients which were eaten per day and head in the several periods. For comparison there is added in the last line of the table the German feeding standard for milch cows, calculated for animals weighing 850 lbs., which was about the average weight of these cows.

SUMMARY OF RATIONS EATEN. POUNDS PER HEAD.

| | Total dry Matter. | Digestible. | | | | | Nutritive ratio. |
|---|---|---|---|---|---|---|---|
| | | Albuminoids. | Non-albuminoids. | Carbohydrates | Fat. | Total. | |
| Preliminary ......... | 19.50 | 1.18 | 0.38 | 9.28 | 0.43 | 11.27 | 1: 6.6 |
| Period I............... | 19.83 | 1.14 | 1.07 | 10.12 | 0.65 | 12.98 | 1: 5.3 |
| Period II.............. | 20.13 | 2.04 | 0.45 | 8.88 | 0.63 | 12.00 | 1: 4.2 |
| Period III ............ | 16.87 | 1.51 | 0.39 | 8.24 | 0.44 | 10.58 | 1: 4.9 |
| German standard per 850 lbs. live wt. | 20.40 | 2.13 | | 10.63 | 0.34 | 13.10 | 1: 5.4 |

As will be seen, the ration varied more or less from period to period, but was in no case very greatly different from the feeding standard. In the rye period it was very nearly the same. In the clover period the amount of protein in the ration was greater and the amount of nitrogenous matter less than in the feeding standard, while in the corn period the ration was below the feeding standard in all respects. The total amount of digestible matter eaten was least in the corn period and greatest in the rye period. The proportion of protein in the ration was rather greater in the last two periods than is called for by the feeding standard. This, however, rather improves the quality of the ration than otherwise, the writer having shown[1] that the greater the proportion of protein in a ration, other things being equal, the greater is the amount of milk which it will produce.

**Yield of milk.**—The milk produced by the cows under experiment was weighed immediately after milking, and an average sample was taken for analysis. In the table which follows, are given the average yield of milk per day and head for each period and also the number of lbs. of total solid matter, of fat and of protein contained in the milk. Details of the daily yields and composition are to be found in the appendix.

AVERAGE YIELD OF MILK AND ITS CONSTITUENTS. LBS. PER HEAD.

| | Total milk. | Milk solids. | Milk fat. | Milk protein. |
|---|---|---|---|---|
| Preliminary............ | 14.46 | 1.84 | .60 | 0.44 |
| Period I.................. | 14.80 | 1.93 | .64 | 0.46 |
| " II.................. | 14.51 | 1.89 | .63 | 0.42 |
| " III............... | 13.22 | 1.68 | .60 | 0.41 |

**Composition of milk.**—The average percentage composition of the milk in each period was as follows:

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[1] Wis. expt. station. Reports II, p. 57; III, p. 97; IV, pp. 114 and 147.

AVERAGE COMPOSITION OF MILK.

| | Total solids. | Fat. | Protein. |
|---|---|---|---|
| Preliminary | 12.75 | 4.15 | 3 01 |
| Period I | 13 01 | 4.32 | 3.14 |
| " II | 13.01 | 4.37 | 2.92 |
| " III | 12.71 | 4.54 | 3.08 |

The quality of the milk, as measured by the percentage of solid matter, was slightly better in periods I and II than in the other periods, but the differences are slight and we may say, in general, that the variations in the feeding had very little influence upon composition of the milk.

**Ratio of food to product.**—The quantity of food eaten havvaried in the different periods, we may compare approximately the nutritive value of the food by calculating how many lbs. of food were required to produce one lb. of milk or butter in each period. We may make the basis of this comparison the total dry matter of the food, or, what is probably preferable, the amount of digestible matter contained in the food. In the table below both methods of calculation have been used, the observed amount of milk being recalculated to the basis of 12 per cent. total solids. We were not able in these experiments to actually make butter from the milk, and consequently we cannot say exactly how much butter it might have yielded, but as an approximate measure of this amount we may take the amount of fat contained in the milk. While in butter making we do not separate all the fat, the weight of the butter is increased by the amount of water and other ingredients besides fat, which it contains, so that the weight of butter produced is frequently as great or even greater than the weight of fat in the milk. At any rate, we may secure in this way, to a certain degree, a comparison of the several periods:

REQUIRED TO PRODUCE 1 LB. OF MILK (WITH 12 PER CENT. OF SOLIDS).

| | Total dry matter. | Digestible organic matter. |
|---|---|---|
| Preliminary | 1 27 | 0.73 |
| Period I | 1.24 | 0.81 |
| " II | 1.28 | 0.76 |
| " III | 1.21 | 0.76 |

REQUIRED TO PRODUCE 1 LB. OF FAT (BUTTER ?).

| | Total dry matter. | Digestible organic matter. |
|---|---|---|
| Preliminary | 32.50 | 18.77 |
| Period I | 30.98 | 20.28 |
| " II | 31 73 | 18.92 |
| " III | 28.09 | 17.64 |

**Yield of milk and butter per acre:**—The proportion of the total digestible matter of the ration which was furnished by the hay, the corn and the soiling crops respectively, was nearly the same in the different periods, with the exception of the preliminary feeding, and in this the proportion furnished by the grain was nearly the same as in the others. The exact figures are as follows :

PERCENTAGE OF DIGESTIBLE MATTER SUPPLIED BY

| | Hay | Soiling | Grain. |
|---|---|---|---|
| Preliminary | 77.91 | ....... | 22.09 |
| Period I | 20.96 | 55.07 | 23.95 |
| " II | 22.71 | 51.40 | 25.89 |
| " III | 4.95 | 50.04 | 25.01 |
| Average I, II and III, | 22.88 | 52.17 | 24.95 |

While in the preliminary feeding the hay furnished fully three-fourths of the digestible matter of the ration, it furnished less than one-fourth of it in the other three periods, the remaining half being supplied by the soiling crops. Nevertheless, we find on reference to the last table, that the amount of digestible matter required to produce a pound of milk or of butter was not greatly different in the several periods, and considering the approximate nature of our estimates of digestibility it does not appear that there was any obvious gain from the introduction into the ration of green food. This conclusion is fully in accordance with the results of the experiment with green and dried grass reported on previous pages. It would appear then that the soiling crops were valuable in proportion to the amount of digestible matter which they furnished, and we may, therefore, properly credit them with a proportion of the milk production corresponding to the proportion of total digestible matter which they furnished. On this basis, we obtain the following figures for the amount of milk and of milk fat (butter) produced by the soiling crops :

PRODUCT DUE TO SOILING. LBS. PER DAY AND HEAD.

| | Milk (with 12 p. ct. solids.) | Milk fat (butter). |
|---|---|---|
| Period I | 8.83 | 0.35 |
| " II | 8.08 | 0.34 |
| " III | 7.00 | 0.30 |

Making allowance for the small amounts of soiling left uneaten, the soiling for one cow for one day was supplied on the average by the following areas :

| | |
|---|---|
| Rye | 181.5 sq. ft. |
| Clover | 113.6 " " |
| Corn | 202.3 " " |

From this table and the one last given we can calculate the amount of milk and butter-fat produced per acre of soiling crops,

YIELD OF MILK* AND BUTTER FAT PER ACRE,

| | Milk. | Butter. |
|---|---|---|
| Rye | 2120 | 85 |
| Clover | 3098 | 125 |
| Corn | 1508 | 66 |

*With 12 per cent. solids,

**Comparison with pasture.**—The above figures furnish the basis for a comparison of pasturage and soiling. We cannot, however, compare the yields as above given directly because, of the three soiling crops, we may grow either rye and corn or clover and corn on the same ground in one season.

**Relative areas required for each crop.**—On the basis of the amounts of the several soiling crops actually eaten by the cattle the relative area of each required is:

| | |
|---|---|
| Rye | 3 |
| Clover | 2 |
| Corn | 3 |

Assuming that each lasts the same number of days. We may get this proportion by means of the following two course rotation:

| | 1st year. | 2d year. |
|---|---|---|
| 1-5 of land, | rye and corn. | Rye and corn. |
| 2-5 " " | clover and corn. | Rye. |
| 2-5 " " | rye. | Clover and corn. |

**Yield of milk and butter per season.**—From the figures given above for the amount of milk and butter-fat produced by an acre of the several soiling crops, we can compute the yield of one acre of ground for one season under the above rotation as follows:

| | Milk. | Butter-fat. |
|---|---|---|
| 3-5 acre of rye | 1272 lbs. | 50 lbs. |
| 2-5 " " clover | 1239 " | 50 " |
| 3-5 " " corn | 905 " | 39 " |
| Totals | 3416 lbs. | 139 lbs. |

These figures show of course, simply the results obtained with the particular cows under experiment, and are probably considerably lower than they should be with good stock. They may serve, however, as a basis for comparison with pasturage. The only comparison possible between the two, however, is on the basis of the yield of digestible matter per acre, since the cow used in the experiment with green grass, already reported, was a better milker than those used in this experiment. As has been noted in another connection, such a comparison may be somewhat unfair to the pasture grass on account of the larger proportion of protein which the latter contains, but we give it for what it is worth. The total product of one acre of pasture for the season was found to be 710.44 lbs. of digestible matter. The cows used in this experiment required on the average of the whole experiment 0.7657 lbs. of digestible matter to produce 1 lb. of milk and 18.9 lbs. of digestible matter to produce 1 lb. of milk fat. At this rate, the 710 lbs of digestible matter furnished by the acre of pasture would produce 928 lbs. milk and 38 lbs. of milk fat, so that the comparison with soiling crops stands as follows:

PRODUCT PER ACRE.

| | Milk | Milk-fat. (Butter ?) |
|---|---|---|
| Soiling | 3416 | 139 |
| Pasturage | 928 | 38 |
| Difference | 2488 | 101 |

It is not proposed here to enter into any consideration of the financial side of the question as between pasturage and soiling. Some preliminary estimates seem to show a decided advantage in favor of pasturage, but we have made no exact experiments, and until we are able to do so we prefer to keep our conjectures to ourselves.

In conclusion, it cannot be too emphatically stated that the figures and comparisons of the foregoing papers are only tentative and preliminary.

No one spot of grass land can represent all pastures. No single crop of soiling can show all the possibilities there are in the system.

We are well aware that the above experiments are deficient in many respects, and it has been our endeavor to bring forward somewhat prominently these deficiencies in order to guard the reader against rash conclusions from our results. We hope to be able to continue experiments in this direction, and to reach in time more definite results.

Pennsylvania state college agricultural experiment station,
September, 1889.

## APPENDIX.

Tables of daily weighings of animals, fodder, water drunk, and milk and butter produced; daily stall temperatures; composition of daily samples of milk and butter; and fresh air-dry weights of fodder samples.

### GREEN vs. DRIED GRASS.

#### FRESH AND AIR-DRY WEIGHTS OF FODDER SAMPLES.

| Date. | Fresh. Grams. | Air-dry. Grams. | Date. | Fresh. Grams. | Air-dry. Grams. |
|---|---|---|---|---|---|
| Preliminary feed'g | | | Digestion period. | | |
| May 29 | 2169 | 650 | June 11 | 2156 | 520 |
| " 30 | 2141 | 527 | " 12 | 2208 | 593 |
| " 31 | 2149 | 622 | " 13 | 2184 | 608 |
| June 1 | 2133 | 692 | " 14 | 2139 | 609 |
| " 2 | 2163 | 708 | " 15 | 2140 | 605 |
| " 3 | 2130 | 591 | | | |
| " 4 | 2171 | 704 | Total | 10827 | 2935 |
| " 5 | 2135 | 608 | Uneaten residues ... | | |
| " 6 | 2125 | 870 | May 31 | 1668 | 723 |
| " 7 | 2170 | 490 | June 1 | 1321 | 450 |
| " 8 | 2168 | 572 | " 5 | 938 | 524 |
| " 9 | 2205 | 590 | " 6 | 1751 | 800 |
| " 10 | 2152 | 467 | " 7 | 1059 | 629 |
| Total | 28014 | 8091 | | 6737 | 3126 |

### GREEN vs. DRIED GRASS.

#### LIVE-WEIGHT, WATER DRUNK AND STALL TEMPERATURE.

| Date. | Weight of Cow. Lbs. | Water drunk. Lbs. | Temperature of stable. Fah.° | Date. | Weight of Cow. Lbs. | Water drunk. Lbs. | Temperature of stable Fah ° |
|---|---|---|---|---|---|---|---|
| Green grass. | | | | Dried grass. | | | |
| May 29 | 730 | 70 | 75 | June 16 | 760 | 70 | 80 |
| " 30 | 750 | 60 | 75 | " 17 | 720 | 125 | 78 |
| " 31 | 750 | 65 | 71 | " 18 | 730 | 70 | 79 |
| June 1 | 760 | 90 | 67 | " 19 | 693 | 145 | 76 |
| " 2 | 775 | 65 | 64 | " 20 | 735 | 80 | 79 |
| " 3 | 785 | 23 | 60 | " 21 | 710 | 135 | 77 |
| " 4 | 755 | 70 | 63 | " 22 | 745 | 95 | 81 |
| " 5 | 770 | 85 | 66 | " 23 | 730 | 115 | 78 |
| " 6 | 790 | 80 | 76 | " 24 | 730 | 120 | 76 |
| " 7 | 795 | 75 | 65 | " 25 | 730 | 125 | 79 |
| " 8 | 800 | 70 | 67 | " 26 | 740 | 80 | 76 |
| " 9 | 793 | 58 | 74 | " 27 | 750 | 75 | 70 |
| " 10 | 785 | 55 | 78 | " 28 | 730 | 85 | 62 |
| " 11 | 778 | 45 | 66 | " 29 | 735 | 100 | 60 |
| " 12 | 775 | 40 | 65 | " 30 | 725 | 120 | 70 |
| " 13 | 770 | 45 | 69 | July 1 | 743 | 85 | 66 |
| " 14 | 770 | 60 | 76 | " 2 | 740 | 90 | 68 |
| " 15 | 780 | 40 | 78 | " 3 | 738 | 103 | 71 |
| | | | | " 4 | 745 | 100 | 75 |

## GREEN vs. DRIED GRASS.

### YIELD AND COMPOSITION OF MILK.

| Date. | Total milk. Grams. | Total solids. | | Fat. | | N×6 25. | |
|---|---|---|---|---|---|---|---|
| | | Per ct. | Grams. | Per ct. | Grams. | Per ct. | Grams. |
| Green grass. | | | | | | | |
| May 30 | 12474 | 12.92 | 1612 | 4.45 | 555 | 3.04 | 379 |
| " 31 | 12020 | 12.64 | 1519 | 4.46 | 536 | 2.66 | 320 |
| June 1 | 11624 | 13.10 | 1524 | 4.02 | 467 | 2.62 | 305 |
| " 2 | 10775 | 13.05 | 1408 | 4.17 | 449 | 2.78 | 300 |
| " 3 | 12332 | 13.47 | 1662 | 4.77 | 588 | 2.48 | 306 |
| " 4 | 10915 | 12.76 | 1393 | 4.33 | 473 | 2.96 | 323 |
| " 5 | 11936 | 12.69 | 1515 | 4.09 | 488 | 2.76 | 329 |
| " 6 | 12815 | 12.79 | 1639 | 3.89 | 498 | 2.57 | 329 |
| " 7 | 11936 | 12.11 | 1445 | 3.60 | 430 | 3.06 | 365 |
| " 8 | 13264 | 12.49 | 1655 | 4.52 | 599 | 3.18 | 422 |
| " 9 | 12985 | 12.49 | 1622 | 3.85 | 500 | 2.71 | 352 |
| " 10 | 11085 | 12.31 | 1364 | 4.07 | 451 | 3.00 | 332 |
| " 11 | 10943 | 12.36 | 1353 | 4.21 | 461 | 3.03 | 332 |
| " 12 | 10775 | 12.85 | 1385 | 4.30 | 463 | 2.64 | 285 |
| " 13 | 11284 | 12.36 | 1394 | 4.54 | 512 | 2.74 | 309 |
| " 14 | 11822 | 11.86 | 1403 | 3.91 | 462 | 2.61 | 309 |
| " 15 | 11766 | 11.21 | 1319 | 3.83 | 451 | 2.70 | 318 |
| " 16 | 11596 | 12.77 | 1481 | 4.52 | 524 | 2.54 | 295 |
| Dried grass. | | | | | | | |
| June 17 | 10718 | 11.85 | 1271 | 4.66 | 500 | 2.54 | 272 |
| " 18 | 10718 | 12.58 | 1348 | 4.03 | 432 | 2.87 | 308 |
| " 19 | 11255 | 12.66 | 1425 | 4.32 | 486 | 2.73 | 307 |
| " 20 | 10943 | 12.14 | 1328 | 4.09 | 448 | 2.56 | 280 |
| " 21 | 11312 | 12.45 | 1408 | 4.34 | 491 | 2.64 | 299 |
| " 22 | 11596 | 11.77 | 1365 | 3.62 | 420 | 2.67 | 310 |
| " 23 | 11878 | 12.16 | 1444 | 4.00 | 475 | 2.87 | 341 |
| " 24 | 13292 | 11.87 | 1583 | 4.42 | 588 | 2.56 | 340 |
| " 25 | 11482 | 11.80 | 1286 | 4.01 | 460 | 2.46 | 282 |
| " 26 | 12672 | 11.79 | 1493 | 3.59 | 455 | 2.63 | 333 |
| " 27 | 12304 | 11.60 | 1434 | 4.60 | 566 | 2.55 | 314 |
| " 28 | 11907 | 12.67 | 1509 | 4.68 | 557 | 2.78 | 331 |
| " 29 | 10886 | 12.83 | 1397 | 3.88 | 423 | 2.55 | 278 |
| " 30 | 11595 | 11.77 | 1365 | 3.94 | 457 | 2.70 | 313 |
| July 1 | 11369 | 12.75 | 1450 | 4.38 | 498 | 2.44 | 277 |
| " 2 | 10491 | 12.37 | 1297 | 4.32 | 453 | 2.58 | 271 |
| " 3 | 11057 | 13.10 | 1448 | 4.40 | 487 | 2.60 | 288 |
| " 4 | 10915 | 11.76 | 1283 | 4.64 | 506 | 2.39 | 261 |

## GREEN vs. DRIED GRASS.

(*Experiment at Wisconsin station.*)

### FRESH AND AIR-DRY WEIGHTS OF FODDER SAMPLES AND LIVE WEIGHT OF COW.

| Date. | Fresh weight. Grams. | Air-dry weight. Grams. | Live wt. of cow. lbs. | Date. | Live wt. of cow. lbs. |
|---|---|---|---|---|---|
| Green grass. | | | | Dried grass. | |
| June 2 | 200 | 46.4 | — | June 16 | 951 |
| " 3 | 200 | 49.5 | 883 | " 17 | 934 |
| " 4 | 200 | 55.4 | 880 | " 18 | 934 |
| " 5 | 200 | 45.0 | 885 | " 19 | 925 |
| " 6 | 200 | 53.7 | 895 | " 20 | 926 |
| " 7 | 200 | 41.5 | 884 | " 21 | 913 |
| " 8 | 200 | 55.2 | 880 | " 22 | 921 |
| " 9 | 200 | 53.0 | 897 | " 23 | 928 |
| " 10 | 200 | 53 5 | 887 | " 24 | 929 |
| " 11 | 200 | 59.8 | 907 | " 25 | 930 |
| " 12 | 200 | 58.0 | 920 | " 26 | 948 |
| " 13 | 200 | 62.2 | 907 | " 27 | 943 |
| " 14 | 200 | 45.0 | 907 | " 28 | 948 |
| " 15 | 200 | 58.0 | 931 | " 29 | 936 |

## GREEN vs. DRIED GRASS.

(*Experiment at Wisconsin station.*)

### YIELDS OF MILK AND BUTTER AND THEIR CONSTITUENTS.

| Date. | Milk. | Milk solids. | | Milk fat. | | Butter. | Butter solids. | | Butter fat. | | Time of churning. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gms. | P. ct. | Gms. | P. ct. | Gms. | Gms. | P. ct. | Gms. | P. ct. | Gms. | Min. |
| Green grass. | | | | | | | | | | | |
| June 2 | 9560 | | | | | | | | | | |
| " 3 | 7962 | 14.47 | 1152 | 5.23 | 416 | 1135 | 86.11 | 977 | 81.09 | 920 | 10 |
| " 4 | 7825 | 14.41 | 1128 | 5.21 | 408 | | | | | | |
| " 5 | 7267 | 14 85 | 1079 | 5.50 | 400 | | | | | | |
| " 6 | 8301 | 14 88 | 1236 | 5.55 | 461 | 1304 | 85.92 | 1120 | 80.33 | 1047 | 20 |
| " 7 | 6767 | 14 74 | 997 | 5.26 | 356 | | | | | | |
| " 8 | 7297 | 14.60 | 1065 | 5 36 | 390 | | | | | | |
| " 9 | 7 08 | 14 76 | 1049 | 5.43 | 386 | 1531 | 85.35 | 1307 | 81.10 | 1242 | 15 |
| " 10 | 7799 | 14.77 | 1152 | 5 77 | 450 | | | | | | |
| " 11 | 8303 | 14 62 | 1214 | 5.63 | 468 | | | | | | |
| " 12 | 7472 | 14 14 | 1056 | 5.45 | 407 | 1843 | 84.50 | 1557 | 80.13 | 1477 | 20 |
| " 13 | 7834 | 14 69 | 1152 | 5.83 | 457 | | | | | | |
| " 14 | 7316 | 14 82 | 1084 | 5.91 | 432 | | | | | | |
| " 15 | 7009 | 14.61 | 1024 | 5.48 | 384 | | | | | | |
| Dried grass. | | | | | | | | | | | |
| June 16 | 7810 | 14 64 | 1144 | 5.38 | 420 | 1219 | 86.86 | 1059 | 83.08 | 1013 | 23 |
| " 17 | 6868 | 14.11 | 969 | 5.01 | 344 | | | | | | |
| " 18 | 7612 | 14 55 | 1108 | 7.55 | 575 | | | | | | |
| " 19 | 8122 | 13.73 | 1115 | 6.88 | 559 | 1332 | 87.98 | 1172 | 84.83 | 1131 | 15 |
| " 20 | 8106 | 14.05 | 1139 | 5.19 | 421 | | | | | | |
| " 21 | 8152 | 14 44 | 1177 | 5.37 | 438 | | | | | | |
| " 22 | 7866 | 13 46 | 1059 | 6.02 | 474 | 1332 | 87.19 | 1161 | 84 01 | 1119 | 20 |
| " 23 | 8697 | 14 76 | 1283 | 5 51 | 479 | | | | | | |
| " 24 | 8969 | 14.50 | 1300 | 5.67 | 509 | | | | | | |
| " 25 | 8639 | 14 08 | 1216 | 5.21 | 450 | 1389 | 87.69 | 1218 | 83.67 | 1162 | 20 |
| " 26 | 8304 | 14 16 | 1176 | 5.26 | 437 | | | | | | |
| " 27 | 8229 | 14.54 | 1197 | 5.73 | 472 | | | | | | |
| " 28 | 8478 | 14.13 | 1198 | 5.45 | 462 | 1304 | 84.65 | 1104 | 80.85 | 1054 | 20 |
| " 29 | 7277 | 14.34 | 1043 | 5.13 | 373 | | | | | | |
| Green grass. | | | | | | | | | | | |
| June 30 | 7736 | 13 92 | 1076 | 5 20 | 402 | | | | | | |

## NUTRITIVE VALUE OF SOILING CROPS.

### AMOUNT OF SOILING EATEN BY SEVEN COWS.

| Date. | Soiling eaten. Lbs. | Date. | Soiling eaten. Lbs. | Date. | Soiling eaten. Lbs. |
|---|---|---|---|---|---|
| Rye. | | Corn. | | Clover. | |
| May 15* | 220 | June 4* | 140 | July 24* | 335 |
| " 16 | 453 | " 5 | 490 | " 25 | 600 |
| " 17 | 580 | " 6 | 510 | " 26 | 1090 |
| " 18 | 470 | " 7 | 450 | " 27 | 765 |
| " 19 | 653 | " 8 | 370 | " 28 | 274 |
| " 20 | 655 | " 9 | 530 | " 29 | 1095 |
| " 21 | 720 | " 10 | 380 | " 30 | 113 |
| " 22 | 655 | " 11 | 600 | " 31 | 775 |
| " 23 | 420 | " 12 | 535 | Aug. 1 | 745 |
| " 24 | 500 | " 13 | 545 | " 2 | 750 |
| " 25 | 415 | " 14 | 580 | " 3 | 814 |
| " 26 | 542 | " 15 | 505 | " 4 | 143 |
| " 27 | 125 | " 16* | 235 | " 5 | 360 |
| " 28 | 393 | | | " 6 | 625 |
| " 29 | 430 | | | " 7 | 698 |
| " 30 | 413 | | | " 8 | 635 |
| " 31 | 463 | | | " 9 | 595 |
| June 1 | 253 | | | " 10 | 560 |
| " 2 | 600 | | | " 11 | 520 |
| " 3 | 135 | | | " 12 | 275 |
| " 4* | 175 | | | " 13 | 335 |
| | | | | " 14 | 530 |
| | | | | " 15* | 167 |

*One feeding only.

## NUTRITIVE VALUE OF SOILING CROPS.

### COMPOSITION AND YIELD OF MILK. SEVEN COWS.

| Date. | Total milk. lbs. | Milk solids. | | Milk fat. | | N.×6.25. | |
|---|---|---|---|---|---|---|---|
| | | Per cent. | Lbs. | Per cent. | Lbs. | Per cent. | Lbs. |
| Dry feed. | | | | | | | |
| May 9 | 102.19 | 12.91 | 13.19 | 4.14 | 4.23 | 3.13 | 3 20 |
| " 10 | 101.19 | 12.62 | 12.77 | 3.98 | 4.03 | 3.15 | 3.19 |
| " 11 | 104 25 | 12.49 | 13.02 | 4.10 | 4.27 | 3 09 | 3.22 |
| " 12 | 103.75 | 12.65 | 13.12 | 4.21 | 4.37 | 3.03 | 3.14 |
| " 13 | 102 88 | 12 74 | 13.10 | 4.12 | 4.24 | 2.99 | 3.08 |
| " 14 | 92.00 | 12.76 | 11 74 | 4.27 | 3 93 | 2.83 | 2.60 |
| " 15 | 102.38 | 12.98 | 13.29 | 4.23 | 4.33 | 2.86 | 2.93 |
| Rye. | | | | | | | |
| May 16 | 99.44 | 12.97 | 12.90 | 4.21 | 4.19 | 2.84 | 2.82 |
| " 17 | 112.00 | 12.80 | 14.33 | 4.16 | 4.66 | 2.96 | 3.32 |
| " 18 | 114 94 | 12.80 | 14.71 | 4.15 | 4.77 | 2.89 | 3.32 |
| " 19 | 116.69 | 13.07 | 15 25 | 4.31 | 5.03 | 3.01 | 3.51 |
| " 20 | 110 75 | 12.90 | 14.29 | 4.29 | 4.75 | 3.05 | 3.38 |

### COMPOSITION AND YIELD OF MILK.—CONTINUED.

| Date. | | Total milk. | Milk solids. | | Milk fat. | | N.×6.25. | |
|---|---|---|---|---|---|---|---|---|
| | | | Per cent. | Lbs. | Per cent. | Lbs. | Per cent. | Lbs. |
| May | 21 | 115.06 | 13.07 | 15.03 | 4.23 | 4.87 | 3.12 | 3.59 |
| " | 22 | 115.00 | 12.83 | 14.75 | 4.32 | 4.97 | 3.08 | 3.54 |
| " | 23 | 113.69 | 13.17 | 14.97 | 4.14 | 4.71 | 3.13 | 3.56 |
| " | 24 | 108.63 | 13.08 | 14.21 | 4.34 | 4.72 | 3.30 | 3.59 |
| " | 25 | 105.50 | 13.06 | 13.77 | 4.01 | 4.23 | 3.42 | 3.62 |
| " | 26 | 103.75 | 13.00 | 13.48 | 4.24 | 4.40 | 3.72 | 3.86 |
| " | 27 | 101.81 | 12.80 | 13.02 | 4.02 | 4.09 | 3.70 | 3.77 |
| " | 28 | 94.56 | 13.34 | 12.62 | 5.09 | 4.81 | 2.96 | 2.80 |
| " | 29 | 96.88 | 13.11 | 12.71 | 3.86 | 3.74 | 2.94 | 2.85 |
| " | 30 | 96.81 | 13.21 | 12.78 | 4.58 | 4.43 | 3.36 | 3.25 |
| " | 31 | 98.44 | 13.10 | 12.90 | 4.76 | 4.69 | 3.44 | 3.39 |
| June | 1 | 95.13 | 12.65 | 12.03 | 4.32 | 4.11 | 2.86 | 2.72 |
| " | 2 | 94.00 | 13.10 | 12.39 | 4.42 | 4.16 | 2.90 | 2.73 |
| " | 3 | 93.94 | 13.01 | 12.22 | 4.58 | 4.30 | 2.72 | 2.56 |
| " | 4 | 85.38 | 13.09 | 11.17 | 4.58 | 3.91 | 3.19 | 2.72 |
| Clover. | | | | | | | | |
| June | 5 | 87.06 | 13.01 | 11.32 | 4.39 | 3.82 | 3.06 | 2.66 |
| " | 6 | 90.56 | 13.32 | 12.06 | 4.22 | 3.82 | 2.86 | 2.59 |
| " | 7 | 91.69 | 13.21 | 12.12 | 4.46 | 4.09 | 3.14 | 2.88 |
| " | 8 | 94.44 | 13.21 | 12.47 | 4.82 | 4.55 | 2.87 | 2.71 |
| " | 9 | 97.44 | 12.79 | 12.47 | 4.31 | 4.20 | 2.94 | 2.87 |
| " | 10 | 107.38 | 12.69 | 13.62 | 4.41 | 4.74 | 3.11 | 3.34 |
| " | 11 | 101.44 | 13.26 | 13.45 | 4.47 | 4.53 | 3.04 | 3.08 |
| " | 12 | 107.81 | 13.12 | 14.15 | 4.19 | 4.53 | 2.67 | 2.88 |
| " | 13 | 107.06 | 13.41 | 14.35 | 4.81 | 5.15 | 2.93 | 3.14 |
| " | 14 | 112.88 | 12.63 | 14.25 | 3.95 | 4.46 | 2.85 | 3.22 |
| " | 15 | 115.94 | 12.85 | 14.90 | 4.01 | 4.65 | 2.81 | 3.26 |
| " | 16 | 105.25 | 12.66 | 13.32 | 4.47 | 4.70 | 2.87 | 3.02 |
| Corn. | | | | | | | | |
| July | 25 | 95.00 | 13.36 | 12.69 | 5.17 | 4.91 | 2.61 | 2.48 |
| " | 26 | 97.69 | 12.98 | 12.69 | 4.77 | 4.66 | 2.88 | 2.81 |
| " | 27 | 102.44 | 13.05 | 13.37 | 4.79 | 4.91 | 2.99 | 3.06 |
| " | 28 | 102.56 | 12.90 | 13.23 | 4.50 | 4.62 | 2.93 | 3.01 |
| " | 29 | 106.94 | 12.13 | 12.97 | 4.35 | 4.65 | 2.57 | 2.75 |
| " | 30 | 96.13 | 12.56 | 12.07 | 4.44 | 4.27 | 2.68 | 2.58 |
| " | 31 | 96.06 | 12.91 | 12.40 | 4.86 | 4.67 | 2.73 | 2.62 |
| Aug. | 1 | 95.56 | 12.90 | 12.33 | 4.14 | 3.96 | 2.67 | 2.55 |
| " | 2 | 91.06 | 12.47 | 11.35 | 4.43 | 4.03 | 2.28 | 2.08 |
| " | 3 | 94.94 | 12.91 | 12.26 | 4.76 | 4.52 | 3.33 | 3.16 |
| " | 4 | 94.00 | 12.78 | 12.01 | 4.74 | 4.46 | 3.56 | 3.35 |
| " | 5 | 95.94 | 11.82(?) | 11.34(?) | 4.19 | 4.02 | 3.28 | 3.15 |
| " | 6 | 90.56 | 12.71 | 11.51 | 4.26 | 3.86 | 4.12(?) | 3.73(?) |
| " | 7 | 88.06 | 12.07 | 10.63 | 4.36 | 3.84 | 3.24 | 2.85 |
| " | 8 | 88.75 | 12.82 | 11.38 | 4.62 | 4.10 | 2.96 | 2.63 |
| " | 9 | 87.81 | 12.64 | 11.10 | 4.41 | 3.87 | 3.17 | 2.78 |
| " | 10 | 88.19 | 12.74 | 11.24 | 4.44 | 3.92 | 3.36 | 2.96 |
| " | 11 | 88.00 | 12.99 | 11.44 | 4.42 | 3.89 | 3.44 | 3.03 |
| " | 12 | 89.25 | 12.70 | 11.33 | 4.36 | 3.89 | 3.18 | 2.84 |
| " | 13 | 79.00 | 12.90 | 10.19 | 4.76 | 3.78 | 3.35 | 2.65 |
| " | 14 | 85.00 | 12.21 | 10.38 | 4.42 | 3.76 | 3.29 | 2.80 |
| " | 15 | 82.50 | 12.75 | 10.52 | 4.57 | 3.77 | 3.30 | 2.72 |

# EDITORIAL.

ON November 12, the association of American agricultural colleges and experiment stations met in Washington, and for four days a most interesting gathering was held. This meeting became one of great importance from the fact that the association was divided into five sections or committees, viz.: agricultural, chemical, horticultural, botanical and entomological. Each section organized, and provided officers for the ensuing year. Programs were adopted, and before the general association meeting was over, the members of the several committees had managed to discuss numerous subjects in the field of technical work.

At first there was complaint that the association was not accomplishing much, but it appeared that quite general satisfaction reigned over the progress of affairs by the time the meeting was half over.

We believe that this association is now in the way to accomplish much good work, and become a power for the advancement of agriculture in the strictest sense. Most fortunately in the past the president, secretary and executive officers have been capable and efficient, and we believe that the officers for the next year are equally business-like and capable.

With programs of papers to be read and discussed before the various committees in future, these meetings cannot fail to be attractive and profitable for station workers to gather at, even if at their own expense, as is the custom when attending the A. A. A. S.

Unlike at the Knoxville meeting, collegiate subjects elicited considerable discussion at the Washington gathering.

It was unfortunate that several colleges and stations were not represented at all at this meeting, for judging from what our business relations with some of them have been, and for other good reasons, they could not have failed to have received much benefit from it.

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# ABSTRACTS.

## A VOLUMETRIC METHOD FOR THE ESTIMATION OF FAT IN MILK.

(By G. E. PATRICK : *Chemical news*, lx, July 5, 1889, p. 5.)

The method consists in bringing all the milk solids, excepting fat, into acid solution in a solvent, which is without sensible action upon the fat, and then measuring the latter at a fixed temperature in a narrow calibrated tube.

The solvent is a mixture of strong acetic acid (80 per cent. or upward in strength), oil of vitriol and concentrated hydrochloric acid, in about the proportion of nine, five and two by volume. The H Cl is added after the mixture of the other two is cooled. These proportions may be varied considerably without much impairing the efficiency of the solvent. Thus, mixtures of nine, four and four volumes respectively, and even nine, three and three, have given good results; but the first mentioned mixture effects solution quicker, gives fully as clear a solution, and, the author has frequently thought, leaves less fat adhering to the walls of the tube as it (the fat) subsides to its place for measurement. Even a mixture of acetic and hydrochloric, or of acetic and sulfuric in the proportions of nine to five or six by volume, does fairly well, but neither is as satisfactory as a mixture of the three.

Any material increase in the amount of H Cl in the various mixtures named, results in more or less turbidity of the milk solution, and thereby renders somewhat difficult the accurate reading of the fat. If from any cause this turbidity ever appears, it can be avoided in a second trial by simply increasing the proportion of acetic acid, making a mixture of about 11, five and two volumes respectively. The increase of acetic acid retards somewhat the solvent action, while giving a lighter colored and clearer solution of the milk solids.

The proportion of the solvent to the milk analyzed may also be varied considerably without affecting the final results. Usually 10.8 c. c. milk and 15 c. c. of the solvent are used. The operation is performed in a tube about 30 c. m. long, of about 17 m. m. capacity, excepting for a distance of seven or eight c. m. near the middle, where it is reduced to a thick-walled tube of about five m. m. calibre. The lower part or body of the tube holds 21 to 22 c. c., and when charged the liquid fills the narrow portion and reaches about two c. m. above it. By means of a lateral perforation in the body of the tube, kept closed by a rubber band (a section of tubing) also perforated, the latter perforation being a little to one side of the former, using a pin as a lever, the liquid may be gradually withdrawn, and the fat made to enter the narrow part, which is graduated in divisions of 0.025 c. c. each. If 10.8 c. c. of milk are taken, one such division=0.2 per cent. of fat measured at 60° C., assuming average densities for both milk and fat. Of course any other scale and any other charge of milk may be employed, provided the tube be correctly proportioned. Before charging the tube there are placed in its lower part two pieces of pumice stone joined together by a bit of platinum wire, to promote regular boiling. In charging the tube the milk is first pipetted in, half or more of the required acid mixture is then added and well shaken with it, and the remainder then poured in—or a quantity sufficient to bring the liquid to the proper hight in the tube. The charged tube is placed on a sand bath, its contents heated to boiling, boiled quite briskly for 10 minutes, then rather gently for 10 minutes or longer if necessary, in order to collect the fat in a layer at the top, and keep it gently agitated with an up-and-down motion until perfectly clear. When the fat layer is perfectly clear, the tube is immediately placed in water at 60° C. for 10 minutes, and if great accuracy is not required, the fat is at once lowered into the graduated tube, and its volume read at 60° after re-immersion in the water for a few moments. In the descent a little fat usually adheres to the tube, making the reading low by 0.05 to 0.2 per cent. Therefore, for exact results, the column of fat is only lowered until its top is just above that of the graduated tube; with a few drops of ether the adhering fat is washed down, the tube is replaced in hot water until the ether is entirely expelled after which the fat is lowered and read at 60° C.

This process is very expeditious; with a little practice one can make three or four determinations, side by side, in an hour and a half.

## TUBERCULOUS INFECTION OF THE FOWL-EMBRYO.

(By A. MAFUCCI: *Centr. f. Bakteriol. u. Parasitenk.*, v (1889), pp. 237–41.)

A cultivation from fowl tubercle was first made on calf's blood serum, and afterwards mixed with sterilized meat broth. On June 28, 1888, a hen and guinea pig were inoculated for control purposes, and at the same time 18 eggs, which were thereupon put under a brooding hen for incubation.

The guinea pig died of tuberculosis in 40 days, and the hen in two and one-half months. On July 17 eight chicks came out; of the rest of the eggs, some had not been fertilized, and the others had become rotten. One showed a dead embryo, but this gave no evidence of tubercle or bacilli. The eight chicks were all small and delicate but active, except one, which died 36 hours after hatching; this contained no tubercle bacilli, though spherical bodies were found among live cells. The second chick died 20 days after hatching, and was much emaciated, and showed tubercle bacilli in nodules in the liver. The third chick died 32 days after hatching, presenting appearances like number two; the fourth chick in 40 days, similar to the fourth; the fifth in 42 days, the most emaciated of the series; no naked eye appearances, but microscopical tubercles in liver, lungs, kidneys, stomach and intestines. Number six died in 47 days; tubercles in liver, lungs and lymphatic elements. Number seven died 78 days after hatching; tubercles evident to naked eye in lungs and liver. Four and one-half months after hatching the eighth died; this was emaciated and poorly developed in comparison to healthy chicks born at the same time. There were malformations of the skeleton in the sternum, vertebral column, pelvis, beading of costal cartilage, in fact all the signs of rickets. The liver and lungs showed tubercles, many of which were caseous, and of course bacilli were found on microscopical examination.

The only inference the author draws from the foregoing experiments, is that the tubercle bacillus of fowls, having penetrated the embryo, is not destroyed, but remains viable, and while not absolutely preventing the development of the embryo, produces its serious effects at a later stage.

The author further expresses the opinion that the virus infects the embryo through the area vasculosa, which pricks it up and passes it on to the liver, for this is the first point at which its effects are perceived. The lung affection is subsequent to that of the liver, for it probably does not take place through the amniotic fluid swallowed by the embryos, since in these the digestive tract is not affected in the same way as it is in the adult.

*Ab.: Jour. roy. micros. soc.*, *1889*, *pp. 569-70.*)

## FOOD OF LARVAL BEES.

(BY A. V. PLANTA : *Zeit. Physiol. Chem.*, xiii, pp. 556-61.)

In a former communication it was stated that the food of the larval drones was different during the first four days and the last four days of larval existence. The same is now found to be the case with the working bees. It was necessary to empty as many as 4,000 cells in order to obtain sufficient material to work with. The queen bees have the same food throughout.

The dry material composition of the food is shown in the following table in per cents :

| | Queen. | Drones. | | Working-bees. | |
|---|---|---|---|---|---|
| | | Under four days. | Over four days. | Under four days. | Over four days. |
| Nitrogenous material... | 45.14 | 55.91 | 31.67 | 53.38 | 27.87 |
| Fat........................ | 13.55 | 11.90 | 4.74 | 8.38 | 3.69 |
| Glucose........................ | 20.39 | 9.57 | 38.49 | 18.09 | 44.93 |

The queen larvæ receive during the whole of their larval condition (seven days) a food which is already digested, and which is especially rich in proteids.

The drone larvæ receive, until the fourth day, a fully digested food which is even richer in proteid than the queen's food ; no doubt this is to hurry on development. After the fourth day, when the larvæ are strong, the feeding bees are not so painstaking ; they prepare only a small part of the food by digesting it, and add to it raw materials in the form of pollen grains and honey. Among the factors in causing this change of diet, must be want of time; for during the months of May and June, the bees have to feed daily 15,000—20,000 larvæ.

With regard to the working bees, much the same may be said, except that pollen grains are never added to the food after the fourth day, but the change in diet is produced simply by admixture with honey. This is probably because the cells of the larval workers are so small; there is no room for an accumulation of undigested pollen husks.

This change which is made in the diet explains a point that has been apparently made practical use of in the lucrative trade in queen bees. This is, that if the queen is removed, a new queen is raised by enlarging the cell and altering the food of a working larva. If the latter, however, has passed the fourth day, that its has begun to receive inferior food, it is impossible or difficult to rear a queen from it.

*Ab.: Jour. chem. soc., 1889, pp. 1022-3.*

## PERCENTAGE OF CARBONIC ANHYDRIDE IN THE AIR OF SOILS.

(By E. WOLLNY: *Landw. Versuchs-Stat.*, 1889, pp. 197-214.)

This is a continuation of previous experiments (*Landw. Versuchs-Stat.*, 1886, pp. 373-91) in which it was shown that the formation of carbonic anhydride was hindered by the presence of vapor of chloroform, whereby the organisms which produce that gas were more or less destroyed. These statements have also been corrobated by Dehérain, who however, states his belief that oxidation proceeds in addition as a purely chemical process. Wollny did not consider this conclusion was justified by results, and so has undertaken new experiments with a view to settle the question, the action of heat and mercuric chloride being employed as antiseptics, and every precaution taken to insure accuracy. The results obtained may be thus expressed: the amount of organic matter in the soil is no indication of the quantity of carbonic anhydride when the organic matter is in excess; the percentage of carbonic anhydride is only proportional to the amount of organic matter when this is in small quantities, but when present in greater amounts, then the carbonic anhydride does increase, but to much less an extent, for the larger or smaller quantity of this gas in the air of the soil more or less reduces the activity of the organisms by whose ageney the oxidation is produced. Water and temperature have a greater influence on the oxidation, and act in an opposite direction to that of the organic matter; the amount of free gas in the soil affords no indication either of the intensity of the action or for the amount of organic matter.

The addition of liquid manure to the soil results in a reduction of the decomposition of the organic matter when the quantity of the salts therein contained is greater than that already present in the soil, but if the liquid manure is dilute and the absorptive power of the soil for salts is great, then the decomposition is promoted.

*Ab.: Jour. chem. soc., 1889, p. 1030.*

## MUCUS DISEASE OF HYACINTHS.

By A. HEINZ : *Centr. f. Bakteriol. u Parasitenk.*, v (1889), pp. 535-9.)

Hyacinths are affected by a wasting disease, attended with the production of a foul smelling mucus. The flowering parts are specially attacked, but no part is exempt. Microscopical examination showed that the mucus and the tissues were full of a bacterium, which is a mobile rod, invariably single, with rounded ends, 4–6 μ long and about 1 μ thick. They propagate by direct fission, and stain well with all the usual dyes.

The bacillus was easily cultivated pure on gelatine, agar and potato, and healthy plants inoculated from these cultivations showed evidences of disease, most marked about the inoculation spot, in 24 hours. Hence the author concludes that this microbe is the actual cause of the disorder, and the name given to it is *Bacillus Hyacinthi septicus.* It does not liquify gelatine. Superficial colonies on plates are circular, about two mm. in diameter, bluish-white in color, with a somewhat darker center. Those lying deeper are oval, and of a dull yellowish-white. The cultivation differences on gelatine and agar are not noteworthy. On potato there forms in 36 hours a yellow slimy layer, and in a few days the cultivations give off a strongly offensive smell.

Other authors, notably Sorauer and Wakker have, described wasting diseases of hyacinths, attended with the production of mucus. These also were caused by bacteria, but Dr. Heinz considers that the disease observed by him is distinct from the yellow and white mucus degeneration of Wakker and Sorauer.

*Ab.: Jour. roy. micr. society, 1889, p. 572.*

## ESTIMATION OF FATTY ACIDS FROM BUTTER.

(By R. WOLLNY : *Milch Zeit.*, xvii, p. 527.)

In an Erlenmeyer flask of 300 c. c. capacity, 6.25 grams of butter fat are weighed. Then 25 c. c. of alcoholic potash, which is equal to 73–74 c. c. of N / 2 sulfuric acid, is added, and the flask closed with a good stopper through which passes a tube 10 mm. wide by 50 mm. long. The flask and contents are now heated for 20 minutes by means of a small flame which must not bring the soap solution to boiling. The flask is next cooled, and 150 c. c. of boiled, distilled water added. After complete solution of the soap, the solution is cooled to 15°, amd 75 c. c. N×2 sulfuric acid is added. The flask is closed with a stopper, and the contents shaken briskly for a minute, when the insoluble fatty acids will form a curdy precipitate, and will allow of the ready filtration of the solution, of which latter 200 c. c. is filtered off and titrated with barium hydroxide solution. A blank experiment made in exactly the same manner, only with the omission of the fat, determines the amount of sulfuric acid added in excess of the alcoholic potash. From the amount of barium hydroxide solution used, the amount of fatty acids soluble in dilute alcohol may be calculated.

*Ab.: Jour. chem. soc., 1889, p. 1037.*

### COFFEE NEMATODE OF BRAZIL.

(By E. A. GOLDI : *Zool. Jahr.*, iv (1889), pp. 262-7.)

The nematode *Meloidogyne exigua* has for nearly 20 years been the cause of disease in the coffee plantations of Brazil. The females are found to form cysts in swellings on the plants, and their vegetative organs are reduced, while their ovary is so swollen as to make the recognition of the vermian nature of the formless sack a matter of difficulty. The ova, which are 0.085 mm. long, have a transparent, thick and resisting membrane. The young are transparent, colorless, and cylindrical, the aboral end being drawn out to a long, fine point ; at the terminal end of the æsophagus there is a cylindrical, muscular swelling. The adults are more club-shaped in form, the aboral end being thicker than the oral, and ending in a sharp spine. A great deal remains to be discovered with regard to the discrimination of the sexes, the manner in which encystation is effected, and the wanderings of the young.

*Ab.: Jour. roy. micros. soc., 1889, Aug., p. 518.*

# EXPERIENT STATION ABSTRACTS.

## AGRICULTURAL CHEMISTRY.

### A NEW METHOD OF MILK ANALYSIS.

(*Kansas experiment station. Report for 1888, pp. 149--64.*)

The following method adopted by Prof. Failyer, is a modification of the process of Dr. W. Schmid, detailed in *Zeit. F. Anal. chemie*, xxvii, p. 464. The method as originally proposed, consists in boiling 10 c. c. of milk with an equal quantity of strong H Cl in a graduated tube until the liquid turns brown. It is then cooled, and shaken up with 30 c. c. of ether. After settling, the volume of supernatant ether is observed, and 10 c. c. of this ether are taken off and evaporated in a tarred dish. The dish and fat are weighed, and from this and the known volume of ether from which the 10 c. c. were taken, the total milk fat is calculated.

The author's method was designed to avoid weighing, combined with rapidity of work. Curd solution could readily be affected in H Cl, but the fat did not readily collect as a whole, hence a solvent seemed necessary. To make the readings volumetric and delicate, a tube having a contracted part, similar to those described by Short, was used, excepting that the bottom was thin, rounded and well annealed, so that the contents could be boiled over a naked flame. The tube in which readings are made is of less diameter, so that smaller differences are apparent.

Following are the necessary materials for analysis: (a) Eight inch tubes drawn off at the top and united with a piece of 4–5 m. m. internal diameter, with funnel top; length 10 inches, with narrow portion 3.5 inches long, the latter graduated. (b) Water bath, about 10 in. deep, with rack inside to support tubes. (c) Means for boiling water in the bath. (d) Two pipettes, of eight c. c. capacity. In measuring the milk, at least one-half minute must be allowed for it to drain down. (e) Glass tube about 4 m. m. external diameter, 18 in. long bent at right angles about five inches from end. (f) A good flame. (g) Something for introducing boiling water into the analytical tube. (h) Bellows. (i) Concentrated H Cl. (j) Gasoline of low boiling point.

In analyzing, 10 c. c. milk are measured into tube, the graduated inside of which should be first moistened with water. The milk is then heated to boiling by flame, and eight c. c. of concentrated H Cl added from pipette. The mixture is then cautiously heated in the flame, and so that the heat is applied to the upper part of the liquid. A floculent mass soon rises to the surface, which contains the butter fat entangled with some portion of other milk solids not readily soluble in acids. To get rid of this latter, the tube contents must be kept very hot and constantly shaken. The flame must never be applied to the bottom of the tube. The heating is continued until, on stopping, the fat globules are seen to be clear as they slide down the side of the tube. The acid liquid will have become black, and the floculent matter disappeared. The heating requires about five minutes.

When the tube contents are cooled below the boiling point of gasoline, but the butter fat yet melted, 15–20 c. c. gasoline are added. The contents of tube are then gently agitated, until the fat is mostly taken up. After standing a while, the gasoline containing the fat will rise to the surface in a clear form.

The tube is next placed in a bath of boiling water, in an ininclined position, so that the gasoline is spread over a large surface, and a current of air is blown in by means of mouth or bellows, which finally evaporates the gasoline. The tube is then filled with boiling water up to where it begins to contract, and the contents not stirred much. The tube is twirled a few times to detach any small globules of fat, and is then placed in bath of boiling water for few minutes to allow the fat to collect in one globule Finally by means of more boiling water the column of fat can be raised within the graduated tube and measured. It is advised to measure while the tube rests in hot water bath.

The analysis of a single sample of milk occupies about 25 minutes, and four can be done in an hour and a quarter.

This method was compared with Babcock's gravimetric one, and with generally good results.

A comparison was also drawn between the work of the churn and the chemist, and as a result the churn was placed secondary in testing.

## ANIMAL NUTRITION.

### COMPARISON OF FODDERS AND RATIONS IN FATTENING STEERS.

(*Iowa agricultural experiment station. Bull. No. 6, pp. 205-37.*)

These experiments were conducted upon 12 steers by Professors G. E. Patrick and L. P. Smith. As much of the report is tabular, we present the authors' conclusions.

With corn and cob meal as the only grain of the ration, corn fodder proved more profitable as the sole coarse fodder, than either timothy hay, corn or sorghum ensilage. Under the same conditions, timothy hay proved more profitable than ensilage with most animals, and two steers lost in weight while fed on ensilage. No difference could be detected between corn and sorghum ensilage in feeding value.

An addition of timothy hay to a ration of corn and cob meal and corn ensilage materially reduced the cost of gain made. With the same addition to rations of corn fodder and corn and cob meal or shelled corn, the reduction in the cost of grain was no more than could reasonably be ascribed to the warmer weather of the period when timothy was fed.

A varied ration of wheat bran, corn and cob meal, corn fodder, timothy hay and either ensilage or mangels produced gain much more cheaply than was done by corn and cob meal and timothy, or by corn and cob meal and ensilage.

Shelled corn produced gain more cheaply than did the same value of corn and cob meal.

Outdoor fattening was found considerably more expensive than indoor fattening, so far as cost of food is concerned.

The following are four comments on the foods used : The corn fodder was especially well liked by all the stock, and in the dairy gave better results than timothy hay. Owing to an exceptionally fine harvesting season, it did not pay to fill the silos with ensilage, as the corn fodder was so much better liked. When fed in moderate quantity with other coarse fodder, the corn ensilage was well relished. Corn and sorghum as ensilage appeared equally desirable.

## FUNGICIDES.

### TREATMENT OF PEAR LEAF BLIGHT.

(*U. S. dept. agric. Section veg. path. Circular No. 8.*)

This experiment was made under the direction of Mr. B. T. Galloway, chief of the section of vegetable pathology, upon pear blight (*Entomosporium maculatum*, Lév.) The work was done in a large nursery near Washington. Two rows of French seedling pears were sprayed with Bordeaux mixture prepared as follows: six pounds copper sulfate, crushed, and dissolved in 16 gals. water. Four lbs. of fresh lime was slaked in six gallons of water. When the two solutions had cooled, they were poured into a barrel and well mixed. This solution was applied by a Japy spraying machine with Vermorel lance and nozzle.

The solution was first applied just as the leaves were beginning to unfold. Ten days later the beneficial results were plainly apparent. On June 5 the first general application was made, and four others at 10 day intervals, 125 gals. being used each time, and 50,000 seedlings were treated. On July 15, when budding began, the plants, with very few exceptions were in excellent condition, and have remained so, retaining nearly all their leaves.

Not three hundred yards from these trees, are probably 10,000 budded pears of different varieties, which have lost nearly all their leaves from blight. These were not sprayed.

### ON PREVENTING THE INJURIES OF POTATO ROT.

(*Ohio agricultural experiment station. Bull. No. 6, vol. ii, pp. 157–65.*)

This work of determining whether the development of potato rot (*Phytophora infestans*) can be prevented by applying mixtures of copper sulfate to the foliage, and also to learn whether such a combination of this fungicide with London purple or some similar insecticide could be made, to prevent the injuries of Colorado beetles and the fungus, was conducted by C. M. Weed.

The solution used by means of spraying, was the Bordeaux mixture, which has already been described in this magazine. The author diluted the mixture about one-half, using six lbs. copper sulfate and four lbs. lime to 50 gal. water. Applications were made May

28, June 6, and 29 and finally July 16. From the results we glean: The treated portions of 20 rows examined, yielded 2,471 potatoes, weighing 320 lbs. seven ounces, and that 1,128 of these were marketable tubers, and weighed 244 lbs. two ounces, while the untreated portions of the same rows yielded 2,771 potatoes, weighing 274 lbs, four ounces, of which 948 were of marketable size and weighed 180 lbs. one ounce. There was thus a total increase in favor of the treated hills of 46 lbs. three ounces, and 64 lbs. one ounce marketable product.

In paragraph five of this bulletin, page 163, third line from bottom of paragraph, the word "untreated" should be "treated." The following table is of interest:

| Name variety. | No. rows. | Total No. potatoes. | Wt. total product. | No. marketable tubers. | Wt. marketable tubers. |
|---|---|---|---|---|---|
| Early Ohio, treated | 4 | 536 | 67 lbs. 4 ozs. | 231 | 48 lbs. 6 ozs. |
| " " check | 4 | 496 | 50 " 0 " | 200 | 34 " 4 " |
| Increase | | | 17 " 4 " | | 14 " 2 " |
| Early Oxford, treated | 5 | 622 | 87 " 1 " | 321 | 70 " 4 " |
| " " check | 5 | 707 | 77 " 4 " | 267 | 53 " 2 " |
| Increase | | | 9 " 13 ' | | 17 " 2 " |
| Puritan, treated | 6 | 727 | 93 " 6 " | 327 | 70 " 4 " |
| " check | 6 | 810 | 83 " 12 " | 266 | 53 " 15 " |
| Increase | | | 9 " 10 " | | 16 " 5 " |
| Lee's favorite, treated | 5 | 586 | 72 " 12 " | 249 | 55 ' 4 " |
| " " check | 5 | 658 | 63 " 4 " | 175 | 38 " 12 " |
| Increase | | | 9 " 8 " | | 16 " 8 " |
| Total treated | 20 | 2,471 | 320 " 7 " | 1,128 | 244 " 2 " |
| " check | 20 | 2,771 | 274 " 4 " | 948 | 180 " 1 " |
| Total increase | | | 46 " 3 " | | 64 " 1 " |

## INSECTICIDES.

### EXPERIMENTS WITH INSECTICIDES.

(*Ohio agricultural experiment station. Bull. No. 6, vol. II, pp. 131–48.*)

*Experiment with cherries.* This is a duplicate experiment with the one of 1888 at this station, on one-half acre of early Richmond cherries. One half of the orchard was sprayed at three different periods, with London purple solution—one oz. to 10 gal. water—and one half used for check. Then 1,000 cherries were picked from each of 24 trees in each half of the orchard. Of the 24,000 cherries from the sprayed trees, 360 had been injured by curculios, while 1,483 of the unsprayed were defective, giving a percentage of benefit from the sprayed over unsprayed of 75.6 per cent. The author, Mr. C. M. Weed thinks spraying with arsenites cheaper and more practical than any other method of preventing insect injuries.

*Experiments with striped cucumber beetle* (*Diabrotica vittata*). Four methods were adopted to prevent the ravages of this pest. (1) By means of strong odors. (2) Coating the cucumber plants with substances as mechanical barrier. (3) Coating plants with poisonous substances. (4) Fencing out insects.

In the first case hen and cow manure, kerosene, carbolic acid and bisulfide of carbon were used. All of the above substances excepting carbolic acid were ineffective. Thick felt paper, dipped in carbolic acid and laid upon the hills among the plants- but not in contact with them, kept the plants, from serious in, jury.

In the second case, coal soot, gypsum and saltpeter were used but no satisfactory results were secured.

In the third class, pyrethrum, slug shot, and peroxide of silicates were used. Pyrethrum killed the insects it touched at first, but lost its power. Slug shot injured the plants. Peroxide of silicates had a decided effect in preventing injury and where the plants had been well started, saved them.

The fourth method of mechanical barriers was most satisfactory.

### TREATMENT OF THE APPLE POWDERY MILDEW.

(*U. S. department of agriculture. Sec. vegetable path. Cir. No. 8.*)

The mildew treated was *Podosphæra oxycanthæ* de By., or apple powdery mildew.

Seedling apples could not be budded on account of this disease. The preparation used as fungicide was a solution made by dissolving half an ounce of sulfuret of potassium to the gallon of water, and applied with Japy pump and Raveneau nozzle. This nozzle however did not give satisfaction, and after trying several other nozzles, the cyclone or Eddy chamber nozzle was adopted. As the above fungicide did not hold to the leaves very well, the following solution was substituted for it: six ozs. copper carbonate mixed with half gallon ordinary ammonia in a water pail, added to a barrel of water. The cost of spraying 390,000 trees was $22.80.

On the sprayed trees the mildew did little or no damage, excepting one block of trees from Ohio that were affected when planted. Mildew did considerable damage on untreated trees, especially cherries and small varieties of plums.

## AGRICULTURAL SCIENCE NEWS.

**The first report of the United States secretary of agriculture, for 1889, recently issued, indicates that this official is determined to improve and strengthen this department most materially.**

**It is stated by the *North British agriculturist* that about $2,000 has been voted from the government appropriated, for teaching agricultural science in Edinburgh university, in connection with the class for rural teachers.**

The Kew bulletin for October discusses the following subjects: Bahia piassava (*Attalea funifera*, Mart.; seedlings of sugar cane at Barbados; cinchona in Jamaica; Gambier; and the fibre industry at the Bahamas.

Mr. John K. Ledingham, has been appointed to the agricultural lectureship in the Tamworth agricultural college and training school, Warwickshire, Eng. He has but recently completed a course in Edinburgh university.

We learn from the *Botanical gazette* for October, that 25 papers were presented to the Society for the promotion of agricultural science at the Toronto meeting, Aug. 27 and 28. The following are the officers for 1889-90. President, C. E. Bessey; secretary-treasurer, W. R. Lazenby; third member of the council, T. J. Burrill. All of the above officers are botanists.

The mildew of the apple has been attributed by various writers to different fungi, *Phyllactinia suffulta*, several species of Erysiphe, and *Podosphœra Kunzei*. Dr. P. Sorauer, according to *Hedwigia* (xviii, p. 8.), finds the white tufts on the upper side of the leaf to consist of the conidial form of a fungus closely allied to *Sphœrotheca Castagnei*, and which he describes as f. *Mali* of that species. The peritheces were not found on the leaves themselves, but on the leaf stalks or young branches.

*Errata*. The following changes should be made in the November issue of this journal: *Page 306, line 22*, "milk" should read fodder; on line 31 the word "on" should follow the first comma. *Page 309, line nine*, "was thought necessary to puck" should read, was not thought necessary to pack. *Page 310, line five*, "*clatior*" should be *elatior; line 19 from bottom* should be acid not "acids"; *line eight*, the word "or" should be of. *Page 320, line eight* from bottom "Bronus" should read Bromus. *Page 322, line 11* for "Buback" read Bubach, for "Hoverland" read Haverland, and place a comma after the name Jessie on same line. *Page 323, line 17*, place comma after word major. *Page 324, line 18* from bottom, "conferer" should be confreres.

Mr. Coquillett of the division of entomology of the U. S. department of agriculture, according to *Insect life* (II, p. 92) has been experimenting with rosin wash for red scale. The one giving the best results, was the following: rosin, 20 lbs., caustic soda (70 per cent. strength) 6 lbs., fish oil three lbs., and water to make 100 gallons. To prepare, the materials are placed in a boiler, covered with water and boiled till dissolved, stirring occasionally. After dissolving, the preparation was boiled briskly for about an hour. The boiler was then filled with cold water, which mixed perfectly. When diluted to 100 gallons, neither leaves nor the fruit were injured, while a large portion of the scales were destroyed. The cost is 80 cents for 100 gallons. An orange tree 16 ft. high with 14 ft. diameter, received 14 gallons.

## EXPERIMENT STATION ITEMS.

A special bulletin, giving analyses of 10 commercial fertilizers, was issued from the Tennessee station on Oct. 15.

Bulletin 10 of the Mississippi station is upon dehorning. This is a very practical bulletin, and no report is given of experimental work.

Le Roy D. Brown, president of Nevada state university, and director of the experiment station in that state was removed from office by action of the trustees on Nov. 4, 1889.

Bulletin four of the Florida station is a practical treatise upon peach growing in Florida by the director, Rev. J. P. De Pass. Four pages are devoted to the annual report of the director.

Bulletin 17 of the Vermont station records a test of dairy cows at the Vermont state fair. We note that the highest per cent. of fat received from the milk for 24 hours, was 5.92, and this from a Jersey.

Bulletin seven of the Alabama station, for October, reports upon a test of methods of setting and churning milk, experiments with varieties of vegetables, meteorological report and statement from department of biology.

Bulletin one of the Rhode Island station details its creation and organization. This matter was largely printed in the annual report. The following is the staff: C. O. Flagg, director, *pro tem.;* L. F. Kinney, horticulturist; H. J. Wheeler, chemist; Samuel Cushman, apiarist and H. F. Adams, farmer.

Bulletin six, volume II of the Ohio station contains notes on the following little known injurious insects: Rhubarb beetle (*Lixus concavus*, Say ;) currant worm (*Nematus ventricosus*); green apple-leaf hopper (*Typlocyba albopicta*); rose leaf hopper, (*Typlocyba rosæ*) and cherry tree slug, (*Selandria cerasi.*)

Bulletin No. 17 of the New York station at Geneva, contains a valuable compilation on cattle foods and feeding rations, touching the following questions. (1) Chemical composition of foods. (2) Digestibility of foods. (3) Amount of digestible matter in foods. (4) Feeding rations. (5) Rations fed by New York dairymen.

The office of experiment stations of the U. S. department of agriculture has begun the publication of a periodical entitled "Experiment station record." It is to be issued six times a year, and is intended to contain abstracts of station literature. The first number also contains a list of the publications of the office of experiment stations.

Mr. C. P. Gillette of the Iowa station gives in bulletin six of that station a very interesting record of examinations of stomachs of 22 prairie squirrels (*Spermophilus 13-lineatus*). Forty-six per cent. of the contents of these stomachs was insects, which would indicate that this little mammal is really a benefit to the farmer, especially as web and cut worms were prominent in this food.

The October bulletin of the Tennessee station is upon grasses and strawberries. Prof. F. L. Scribner republishes here the paper read by him before the society for the promotion of agricultural science at Toronto, on grasses of mountain meadows and deer parks. Dr. W. E. Stone gives experimental work on the chemical composition of strawberries, which is largely the matter published in the October issue of this journal, and Prof. C. S. Plumb publishes field notes of tests of varieties of strawberries.

Bulletin nine of the Mississippi station is upon diseases of sheep and calves, by Dr. Phares. The sheep diseases are those caused by Strongylus and Tricocephalus. The symptoms of the malady are given, with methods for prevention. Experiments were made with *Helenium autumnale*, to indicate its effect upon calves. Strong infusions were given, but death followed in no instance, though the drink made the animals sick.

The association of American agricultural colleges and experiment stations had a very successful meeting at Washington from Nov. 12–15. Pres. Smart of Purdue university was elected president, Pres. Gates of Rutgers college, first vice president, and Dr. H. P. Armsby, secretary-treasurer. The association also established five committees or sections, viz: agricultural, chemical, botanical, horticultural and entomological. Hereafter the association of official economic entomologists meets with the entomological committee.

The first annual report of the West Virginia station is quite different in character from most of the station reports, and is almost entirely an executive report, no experiments being detailed. The station had no farm to work upon, at the writing of this report hence too much should not be expected of it. A general description is given of the station building, to cost $4.375. The regents appropriated $2,000, to purchase 13 practical libraries of agriculture, horticulture and veterinary, one to be placed in each senatorial district of the state. For the purchase of a reference library for the station, $3,000 were appropriated. A list of the books for the local libraries is given. A long list of parties to whom the station shipped wheat, corn, oats. phophates, trees, etc., is given. The minor part of this report only, has an experiment station significance. Yet the reader is hardly justified in criticizing this, in view of the embarassments the director has had to contend with.

Bulletin six of the Hatch station of the Mass. agric. college contains a fuller explanation from Professor Maynard concerning the greenhouse heating test of steam vs. hot water. A test of varieties of strawberries is also given, covering from one to 15 years time. Of the old varieties of berries, Crescent, May king, Sharpless, Belmont and Miner's prolific are commended. Of those tested two or three years, Jessie, Bubach and Gandy's prize are good, while Logan, Photo, Haverland, Warfield, Howard's No. 6 and Cardinal are promising. Prof. J. E. Humphrey of the state station contributes to this bulletin an interesting paper on the fungus diseases of plants, and especially discusses the rose leaf black spot (*Actinonema rosæ*, Fr.), the black knot of the plum (*Plowrightia morbosa*, Sacc.) and potato blight and rot (*Phytophthora infestans*, de By). The information is not new, but is nevertheless valuable to the fruit grower, florist and gardener.

Bulletin eight of the Minnesota station discusses siloing clover, by the director; the sources of our home made manures, by W. M. Hays; the bye products of wheat by Messrs. Hays and Harper; and the Rocky mountain locust in Otter Tail county, by Otto Lugger. The chemical tests of wheat screenings show that as a feed the screenings are equal to oats. The entomologist shows, through his article in this bulletin, that he is accomplishing results that will assist in firmly establishing the experiment station in the good will of farmers, and win their approbation. With a county commissioner the entomologist made a study of the locust in a region where it was a serious plague, advised the farmers as to protecting themselves, and assisted in the work to such an extent that the crops were saved. In experimenting with the eggs of the locust it was found as follows:

| | Dry soil produced | Soil occasionally moistened produced. |
|---|---|---|
| Eggs 1 inch below surface. | 93 per cent locusts. | 87 per cent. locusts. |
| " 2 " " " | 86 " " | 43 " " |
| " 3 " " " | 51 " " | 11 " " |
| " 4 " " " | 13 " " | 01 " " |
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# IMPORTANT ERRATA TO VOL. III.

Page 24, Transpose headings "Fat" and "Nitrogen-free extract," second table.
" 79, Read *saponification* for "saporification."
" 80, line 19. For "3.4" read 34.
" 94, " eight. For "plaisade" read *palisade*.
" 127, " 22. For "Mansard" read *Maynard*.
" 165, " two. For "Hymenomycetous" read *Hymenomycetous*.
" 277, " six from bottom. For "plaster land" read *land plaster*.
" 306, " 22, For "milk" read *fodder*.
" " " 17 from bottom. Prefix *on* to "the ensilage question."
" 309, " nine. Should read, *it was not thought necessary to pack the trachea*.
" 310, " five. For "clatior" read *elatior*.
" " " 19 from bottom. For "acids" read *acid*.
" " " eight from bottom. Change "or" to *of*.
" 320, " 20 from bottom. For "Buckmans" read *Berckmans*.
" " " eight from bottom. "Bronus" read *Bromus*.
" 322, " 11. For "Buback" read *Bubach*; for "Hoverland," *Haverland*, and place comma after "Jessie."
Page 341. Last table, last column should read *Butter fat*.
" 347. Transpose the headings "Corn" and "Clover."
" 349. Add word *it* to end of editorial article.

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